THE INSTITUTION OF PRODUCTION ENGINEERS JOURNAL

JUNE 1956

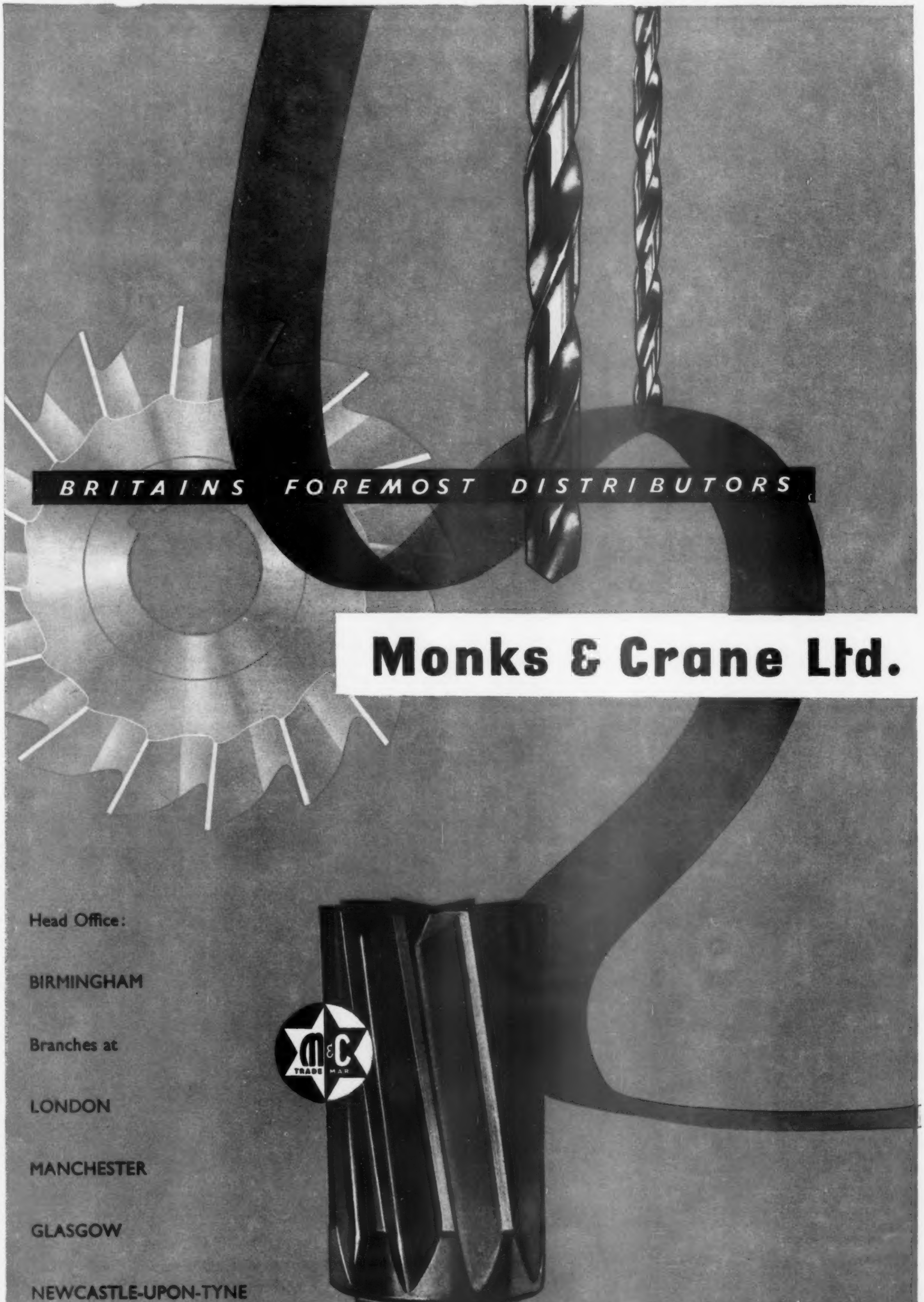
THE INSTITUTION OF

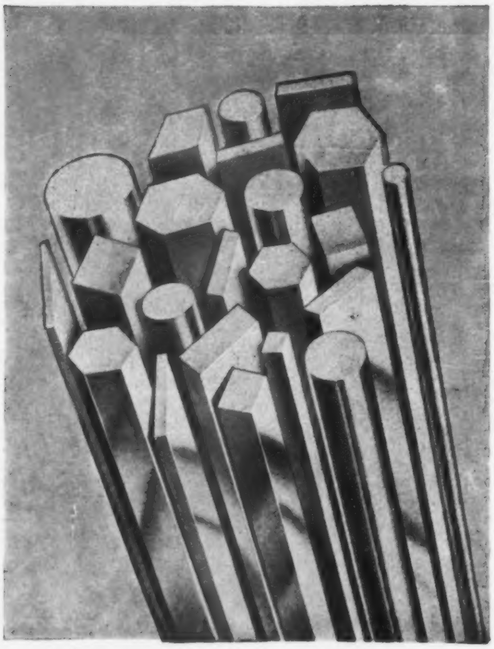
PRODUCTION ENGINEERS JOURNAL

10 CHESTERFIELD STREET . LONDON . W1 Telephone : GROsvenor 5254/9

Vol. 35, No. 6 *Price 10/-* *June 1956*

CONTENTS


BRITAINS FOREMOST DISTRIBUTORS
Monks & Crane Ltd.
Head Office:
BIRMINGHAM
Branches at
LONDON
MANCHESTER
GLASGOW
NEWCASTLE-UPON-TYNE
M&C
TRADE MARK



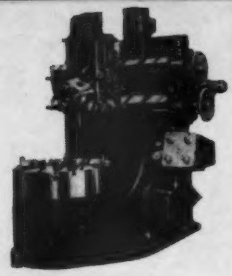

TRADE MARKS
B·S·A TOOLS GROUP
BSA
BURTON GRIFFITHS
LEO. C. STEINLE
STAND NOS 48 & 49
GRAND HALL
& NO. 423 GALLERY
NATIONAL HALL
INTERNATIONAL MACHINE TOOL EXHIBITION 1956
June 22-July 6
Olympia · London
B.S.A. TOOLS GROUP
BRITISH · AMERICAN · EUROPEAN
MACHINE TOOLS DIVISION: KITTS GREEN · BIRMINGHAM 33 TELEPHONE STECHFORD 3071
SMALL TOOLS DIVISION: MONTGOMERY STREET · BIRMINGHAM 11 TELEPHONE VICTORIA 2351

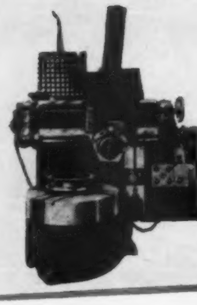
if you miss the bus there's usually another
if you miss Cutanit
(a Metro-Cutanit Product)
you're surely
left behind
The fact of the matter is that 'Cutanit' is now widely acknowledged as the finest cemented carbide obtainable. Not so well known, though, is the multifarious number of uses to which Cutanit is being put. Not only is it being used for cutting all kinds of materials efficiently but it is also finding increasing application to many problems involving excessive wear.
If you think that there might be the slightest connection with the tremendously hard, consistent quality of 'Cutanit' and your own mechanical problems, we shall be glad to be of service.
Cutanit
WM JESSOP & SONS LTD
BRIGHTSIDE WORKS SHEFFIELD
J J SAVILLE & CO LTD
TRIUMPH WORKS SHEFFIELD
Enquiries to:- SMALL TOOL WORKS, PORTLAND STREET, SHEFFIELD, 6.
INTERNATIONAL MACHINE TOOL EXHIBITION 1956
June 22-July 6
Olympia · London
Visit our Stand No. 509, 1st Floor, Empire Hall. We are operating a tool regrinding and reconditioning service for the use of other exhibitors demonstrating their machines with cemented carbide tools.

WEBSTER & BENNETT

BORING AND TURNING MILLS

Webster & Bennett machines, all with hydraulic control to tool slides, are available with 36", 48" and 60" chucks, the smaller machines also being built in duplex forms.



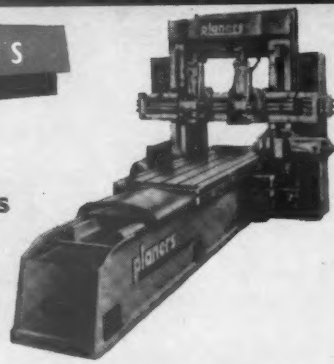


ELECTRONIC PROFILE TURNING EQUIPMENT

Machines can be supplied with Profile Turning Equipment enabling complex forms to be reproduced from simple templates under electronic control.

PLANERS

PLANING MACHINES



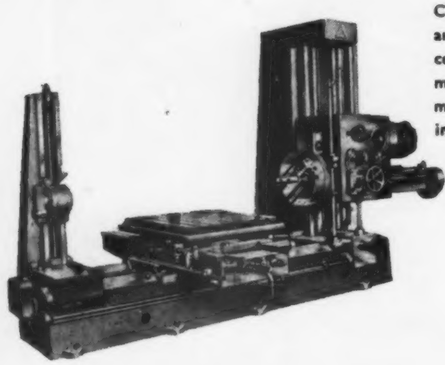
The range of machines built by Planers constitutes three basic types made in a wide range of sizes extending from 2' 6" wide by 6' 0" long to 6' 0" wide by 26' 0" long.

Machines are available with Worm Reduction Gear Drive or Spiral Drive, for light or heavy duty respectively. Specific proposals will be gladly submitted on request.

METAL

COLLET & ENGELHARD

HORIZONTAL BORING AND MILLING MACHINES

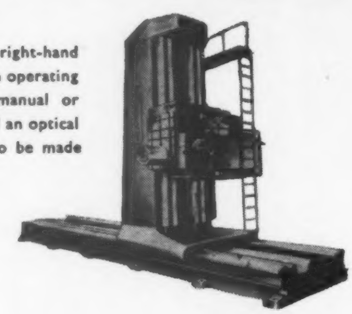


Collet & Engelhard machines are designed with right-hand arrangement of centralized controls for maximum operating convenience. Work-table is provided with manual or mechanical movement in feed or fast motion, and an optical measuring device enables readings to 0·0004" to be made in all directions.

Type BFf115

Diameter of spindle	$4\frac{17}{32}$"
Boring depth (one setting)	$39\frac{3}{8}$"
Diameter of Face Plate	$23\frac{1}{2}$"
Diameter bored	$27\frac{9}{16}$"
Diameter faced	$39\frac{3}{8}$"

Other sizes available with spindle diameters from 4" to $11\frac{3}{4}$".



Other machines in the Collet & Engelhard range include :

Floor and Planer type Boring & Milling Machines.
Die-sinking Machines.
Milling Cutter Grinding Machines.

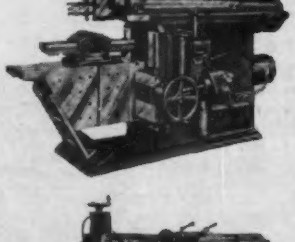
KLOPP

HYDRAULIC SHAPING MACHINES

For all types of production work. Designed with infinitely variable ram speeds, stroke adjustment during operation, and hydraulically operated table feed.

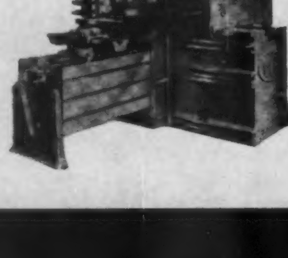
Machine illustrated Type 650H

Maximum stroke	26"
Planing width	27"
Height of work	33"



Traversing Head Type TH/1000/2/1

Maximum stroke	$39\frac{3}{8}$"
Planing width	$39\frac{3}{8}$"
Table to ram	$33\frac{1}{2}$"



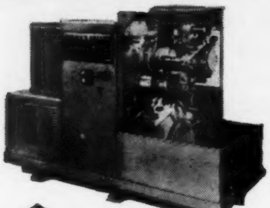
WEIPERT

PRODUCTION COPYING LATHES

Height of centres	$9\frac{7}{8}$"
Swing over bed	$20\frac{7}{8}$"
Swing, copying (template)	$11\frac{3}{4}$"

These powerfully built machines are designed for copy-turning large and heavy components, and are available in a range of seven bed lengths extending from 20" to 118" between centres. Copying accuracy ± 0·0002".

WARNER & SWASEY



2 AC AUTOMATIC CHUCKING MACHINE

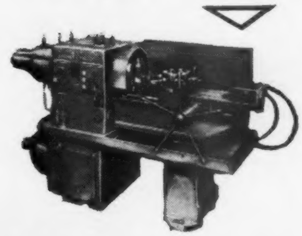
For batch and mass-production.

Swing over cross slide	10¼"
Spindle to turning head	28"
Turret working stroke	9"
Cross slide stroke	4½"

16" ELECTRO CYCLE TURRET LATHE

Specially designed for fast machining of non-ferrous components. Air chuck and automatic control to all spindle functions.

Swing over bed	16½"
Swing over cross slide	9"
Spindle to turret face	21½"
Bar capacity, round	1½"



LORENZ

FN6 HEAVY DUTY HOBBING MACHINE

A double frame machine for gears up to 23½" dia. and maxi (Module 6). Programme c applied. Maximum workpiec

SR-O HIGH SPEED GEAR SHAPING MAC

Developed to cut short face and helical spur gears, intern up to 6·35 D.P. Max pitch

CUTTING MACHINE

HELLER

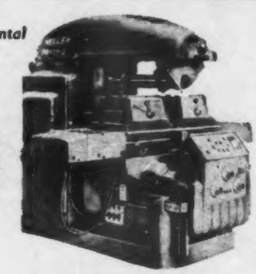
FH.120-2 HORIZONTAL MILLING MACHINE

Of extremely robust design, embodies vibration damped spindle in large anti-friction bearings, Automatic hydraulic clamping to knee, fan cooled column and radiator cooled hydraulic oil. Table movements are controlled by electro-hydro-mechanical device, and back-lash eliminator fitted.

Programme control can be applied for automatic cycling.

Table surface	63" x 14"
Longitudinal stroke	47"
Vertical adjustment	16"
Cross adjustment	12½"
Main motor	19 h.p.

FH 120-2 Horizontal Milling Machine



FV.160 VERTICAL MILLING MACHINE

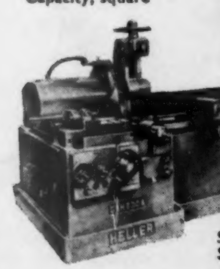
Exactly similar construction and features to FH.120-2 but of larger capacity. Can be equipped with tracer control and copy milling devices.

Table surface	78" x 18"
Longitudinal stroke	55"
Vertical adjustment	18"
Cross adjustment	16"
Main motor	37½ h.p.

KA.315 AUTOMATIC CIRCULAR SAWING

Specially designed for batch or m cutting of iron and steel bar, pipe Accurate cut-off length between hydraulic clamping. Safety device unit.

Maximum blade diameter
Width of cut
Capacity, round
Capacity, square



SS
So

Wickman High Production Machine Tools cover every aspect of contemporary production ranging from simple primary machines to fully "automated" transfer milling lines.

Specialist sales engineers with extensive personal experience of the newest and most profitable production techniques are always available to discuss the choice and application of these processes to individual problems.

Feel free to call upon them at any time.

BRITAIN'S LEADING MACHINE TOOL SPECIALISTS

WICKMAN LIMITED

FACTORED MACHINE DIVISION, FLETCHAMSTEAD HIGHWAY, COVENTRY

Telephone: Coventry 40351

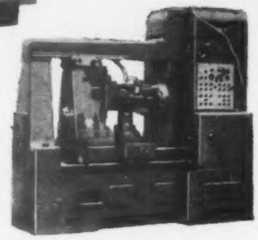
'CLE
THE

chining
. Air
rol to

16¾"
9"
21¼"
1½"

LORENZ

FN6 HEAVY DUTY HOBBING MACHINE



A double frame machine for spur and worm gears up to 23½" dia. and maximum 4·23 D.P. (Module 6). Programme control can be applied. Maximum workpiece dia., 23½".

SR-O HIGH SPEED GEAR SHAPING MACHINE

Developed to cut short face width straight and helical spur gears, internal and external up to 6·35 D.P. Max pitch diameter, 7$\frac{3}{16}$".

DA

A ful
" tu
slide
mov
simu
enab
0·00
Stan
$\frac{3}{16}$"
squa
diffe
leng
2¼".
r.p.r
slott
and

MACHINE T

ICAL
CHINE

n and features to
apacity. Can be
ntrol and copy

78" x 18"
55"
18"
16"
37½ h.p.

KA.315 AUTOMATIC COLD CIRCULAR SAWING MACHINE

Specially designed for batch or mass production cutting of iron and steel bar, pipe, sections, etc. Accurate cut-off length between ¼" and 20", hydraulic clamping. Safety device fitted in feed unit.

Maximum blade diameter	12½"
Width of cut	$\frac{3}{16}$"
Capacity, round	3½"
Capacity, square	3⅛"

SSH 630A Automatic Sawing Machine

SS

Dev
tion,
to l
Infin
prov
Piec
pre-
pro

C A

Tools cover every aspect of con-
simple primary machines to fully

ensive personal experience of the
on techniques are always available
ese processes to individual problems.
e.

HINE TOOL SPECIALISTS

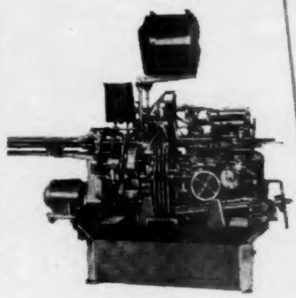
LIMITED

HAMSTEAD HIGHWAY, COVENTRY
ry 40351

DAVENPORT

MULTISPINDLE SCREW MACHINES
(5 Spindle)

A fully automatic machine with five "turret" tools and four cross slide tools, each with independent movement. All operations are simultaneous and suitable tooling enables tolerances as close as 0·001" or less to be maintained. Standard capacity of feed tubes $\frac{9}{16}$" round, ½" hexagon, and ⅜" square. Special feed tubes for different size stock available. Max. length fed 3". Max. length turned 2¼". Spindle speeds 750—3,000 r.p.m. Attachments for screw slotting, rotary slotting, de-burring and cross drilling.



DUBIED

RAPID COPYING LATHES

These high-speed machines are designed for copying small and medium size components direct from a workpiece or a 1 : 1 template.

Machine illustrated Type 514 x 650

Distance between centres	25⅝"
Height of centres	4¼"
Turning diameter	4 $\frac{3}{16}$"

A smaller machine with 15¾" between centres is available.

Constant cutting speed

Type 515 operates constant cutting speed at all diameters.

TOOLS

SSH.630A AUTOMATIC COLD CIRCULAR SAWING MACHINE

Developed for fully automatic operation, stock is fed by hydraulic means to length, and hydraulically clamped. Infinite variation of cutting speeds is provided, incorporating safety device. Piece counter stops machine when pre-determined number of pieces produced.

Maximum blade diameter	25"
Width of cut	¼"
Capacity, round	8¼"
Capacity, square	7⅜"

SA.315 SAW BLADE SHARPENING MACHINE

Capacity 3 $\frac{5}{32}$" to 14" dia.
Width of cut $\frac{3}{16}$"
Wheel diameter 6"

Heller also build :

Unit-designed Plano-milling machines.
Boring and facing units.
Transfer milling lines, and a wide range of special purpose machine tools.

WICKMAN-MOULTON

THREAD MILLING MACHINES

Suitable for low cost batch production. Internal or external threading, either hand, can be milled ranging from fine pitch threads to 8 T.P.I. Leadscrews for British, American and Continental threads. Operation is rapid and automatic and multitype cutters form the whole length of thread in a little over one revolution of the work spindle.

Model 1B

Maximum diameter milled external	6"
Maximum diameter milled internal	7½"
Maximum distance between spindles	24"
Cutter speeds range	100–310

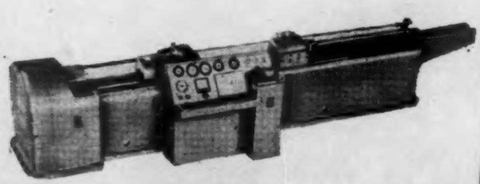
Model 2 provides for internal and external milling up to 12" diameter.

CARLSTEDT

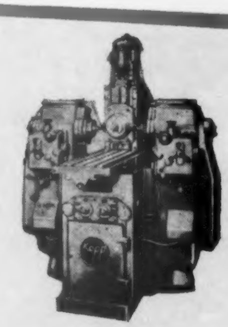
DEEP HOLE BORING MACHINES

These machines are designed for solid boring and trepanning by the B.T.A. method and are available in a range of sizes with maximum boring diameter of approximately 4¾" and maximum boring depth of 15' 0".

Machines are operated from a central control desk, automatic controls in the hydraulic feed ensuring smooth semi-automatic operation.

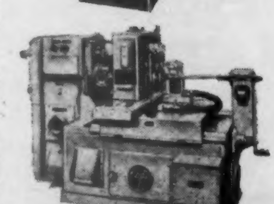


KOPP



KPF1/n THREE DIMENSIONAL MILLING MACHINE

This two-spindle hydraulic tracer-controlled machine is designed for two or three dimensional milling in one operation. Capacities : Cutter diameter 1½" ; table traverse 12" ; cutter stroke 3" ; table surface 55" x 8".



UKF2 COPY MILLING & GRINDING MACHINE

Designed for milling profiles of face, drum and plate cams ; worms, threads, turbine blades, pump impellers, valve plate slots, etc., by hydraulically controlled tracer.

Table surface 45" x 15¾".

GRINDING & HONING MACHINES

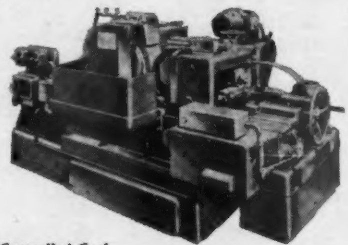
SCRIVENER

CENTRELESS GRINDING MACHINES

The range of machines built by Arthur Scrivener Ltd. comprises types for through grinding wire, bar and tube, and Controlled Cycle machines for Automatic plunge grinding on a mass production basis.

SURFACE GRINDING MACHINES

Scrivener also make a range of high-precision reciprocating table Surface Grinding Machines, and a Duplex Surface Machine for grinding two parallel faces in one operation.

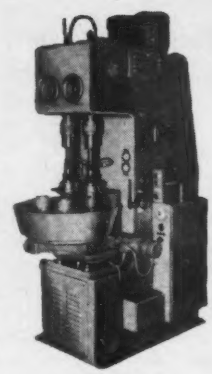


2G Controlled Cycle Centreless Grinder

NAGEL

HONING MACHINES

For mass-production superfinishing to the highest limits of accuracy on automatic cycle operation. Available in single and multi-spindle types.



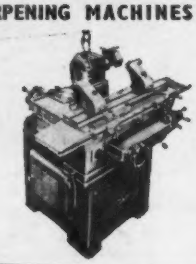
SUPERFINISHING SPINDLES

For mounting on existing machines, particularly lathes for superfinishing machined faces.

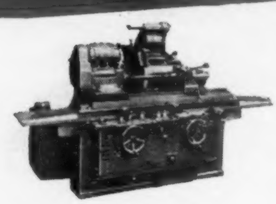
HARO

UNIVERSAL TOOL-CUTTER, PRECISION GRINDING & SHARPENING MACHINES

Covers full range of internal and external grinding operations. 360° swivelling head and capacities up to 44" between centres.



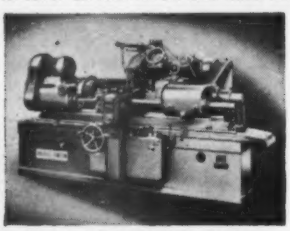
NAXOS-UNION



Type RU 250 Plain Grinding Machine

CRANKSHAFT GRINDING MACHINES

Naxos-Union Multiple Wheel, dual head plunge grinding machines are built in accordance with the established Naxos principle of unit construction. Sizes are available to cover all four-throw and most six-throw crankshafts.



Type K 450 Crankshaft Grinder

UNIVERSAL CYLINDRICAL GRINDING MACHINES

Naxos Universal Grinding machines are designed to retain the utmost flexibility and ease of setting and yet be capable of fully automatic cycle on plunge grinding production operations. Built in a wide range of sizes.

The Naxos range also includes :
Plain, Roll, Surface, and Internal Grinding Machines.

WICKMAN-NEVEN

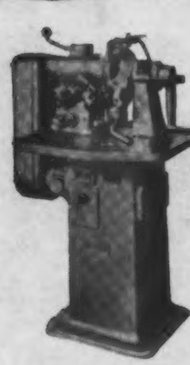
TOOL GRINDING MACHINES

These bench-mounted machines are particularly designed for grinding and lapping carbide tools.

Type G.F.2 accommodates a 6" Neven diamond wheel and is suitable for lapping tools up to 1" square.

Type G.F.3 is of universal design and is suitable for grinding chip-breaker grooves and precision rakes and angles on lathe tools.

ORTLIEB



OS 11A Twist Drill Grinding Machine

OS11A DRILL GRINDING MACHINE

A universal machine for accurate drill grinding by semi-skilled operators. Grinds drills either hand from 0·04"—0·59" dia. with tip angles from 60°—140° and without interfering with back-off cone angle. Relief angles can be ground from 0°—12°.

O.B.D. LEAD GRINDING MACHINE

A high-grade machine for maintaining cutting tools in first-class condition. Cutting edges can be positively ground to identical rakes and relief angles preset as required.

Maximum distance between centres 8·662"

Chucking capacity in 10 steps from

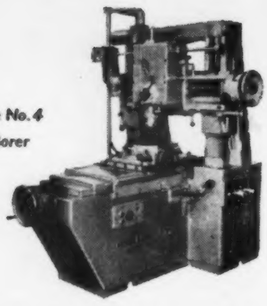
MIPSA

UNIVERSAL HIGH PRECISION GRINDING MACHINES

Made in two sizes, 16" and 30" between centres, with compound Slides to Wheelheads, and swivelling tables and headstocks. Automatic cycle working and sizing if required. Production types also available.

HAUSER

HIGH PRECISION JIG BORING AND JIG GRINDING MACHINES



Type No. 4 Jig Borer

and special purpose machines for watch and precision instrument manufacture.

SAFAG

Auto. Form Cutter Milling Machine

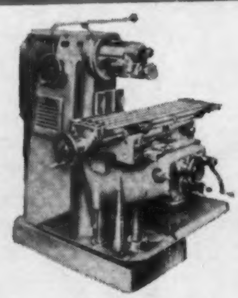
Auto. Wheel and Segment Cutting Machine

MILLING AND GRINDING MACHINES

A range of milling and grinding machines for small precision tool manufacture, and special purpose machines for the watch and clock industry.

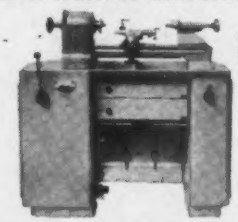
TOOLROOM & INSTRUMENT PRODUCTION

SCHAUBLIN



Type 53 Universal Milling Machine

UNIVERSAL TOOLROOM MILLING MACHINES, TURRET, TOOLMAKERS' & LEAD SCREW LATHES

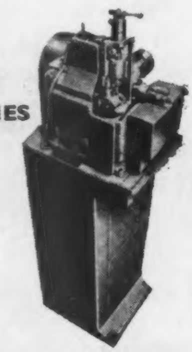


Type SV 102 Toolmaker's Lathe

The range of machines built by Schaublin comprise Lathes and Milling Machines of the highest precision standards. All machines in the range are built on unit construction principles.

LAMBERT

GEAR HOBBING & GENERATING MACHINES



Instrument Gear Hobbing and Generating Machines, and Automatic Facing and Recessing Machines, for watch, clock and high precision instrument manufacture.

ETAMIC

AIR-OPERATED INSPECTION AND SIZING EQUIPMENT

Comparator Units for inspection of single and multiple dimensions.
Size control units for high precision cylindrical and surface grinding machines, and strip mills.

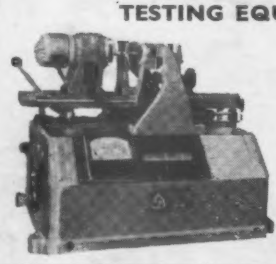
CARY

A comprehensive selection of precision gauges and test instruments for every application in the engineering and watch-making industries.

Cylindrical plug gauges, snap gauges and testing discs, ring gauges, slip gauges, straight edges and precision comparators with accuracy ± 0·00008".

LOSENHAUSENWERK

BALANCING AND TESTING EQUIPMENT



Static and Dynamic Balancing Machines. Fatigue Testing machines for static and dynamic, tensile, compression and bending tests. Pendulum Impact Testing Machines.

In addition to the Companies and products shown here, Wickman also represent the following :

Baker Bros. Inc., OHIO, U.S.A.
Keyseating Machines.
Special Purpose Machine Tools.

Carlton Machine Tool Co., OHIO, U.S.A.
Radial Drilling Machines.
From 12 ft. arm and 4" dia. hole to 6 ft. arm and 3" drilling capacity.

Habersang & Zinzen, G.m.b.H.
Drilling, Tapping and Reaming Machines ; Multi-spindle, Multi-station, Rotary and in-line Transfer machines.

The R.K. Le Blond Machine Tool Co., OHIO, U.S.A.
Lathes and Automatic Crankshaft Turning Machines.

Leland-Gifford Co., MASS., U.S.A.
Standard and Special Sensitive and Hydraulic Feed Drilling Machines.

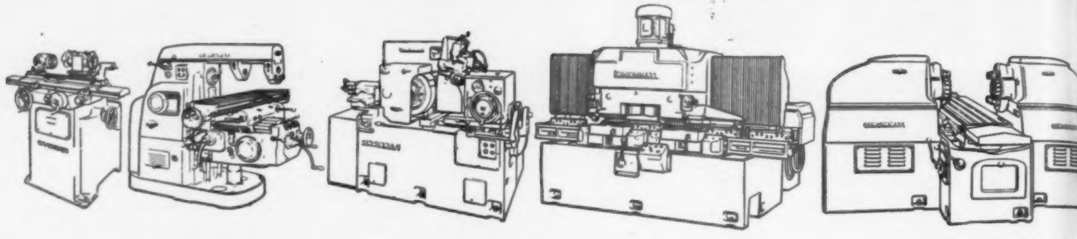
METAL FORMING

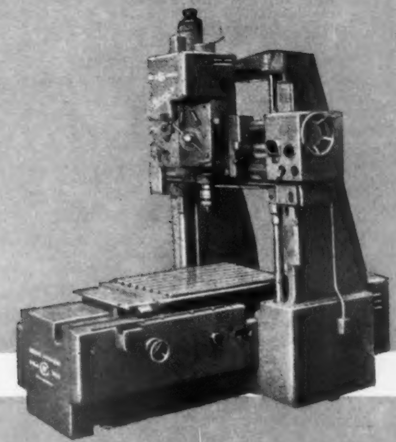
Metal-forming machines covering forging, hammering, blanking and piercing, drawing, tube making and bending, strip forming and stretch-wrap forming, are briefly described in a companion leaflet, W.141.

WICKMAN LIMITED

FACTORED MACHINE DIVISION, FLETCHAMSTEAD HIGHWAY, COVENTRY

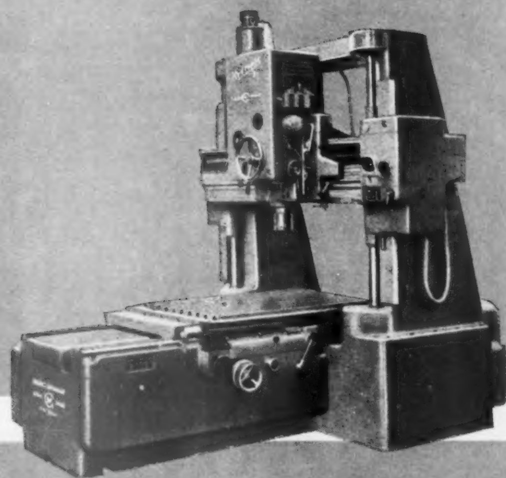
HF W 143





HYDROPTIC 6

Complete information about the jig boring machines made by Société Genevoise will be available on the Exhibition Stand. If you would like up-to-date literature about any item, yet are unable to visit us there, please write, or telephone Temple Bar 2126.



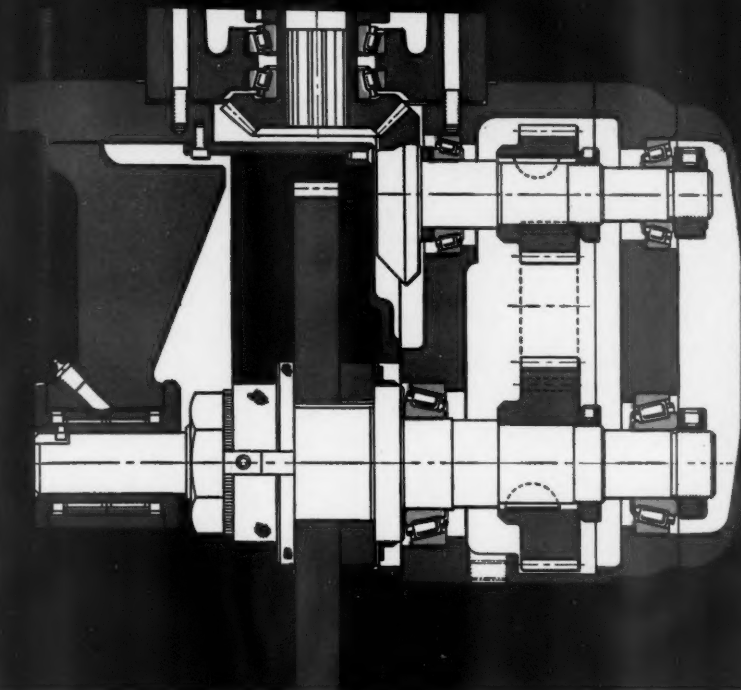
HYDROPTIC 7 P

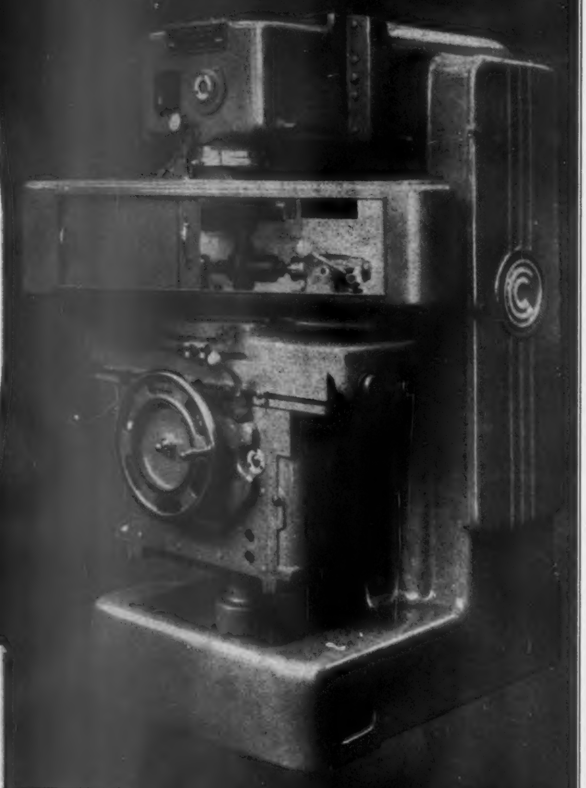
Sogenique Service . . .

Area Engineers provide country-wide maintenance of Société Genevoise machines. The installation and service of these machines is carried out by Sogenique (Service) Limited under the GSIP guarantee. Prompt service is available whenever required.

HYDROPTIC 8P

5-6 Brettenham House, Lancaster Place, London, W.C.2

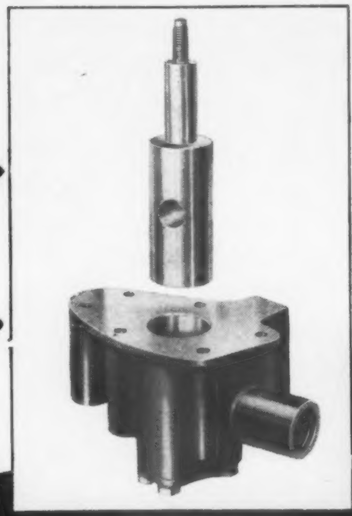





from any angle...
AMERICAN STANDARD
ENGLISH STANDARD
UNIFIED STANDARD
METRIC STANDARD
UNBRAKO
Always right!
UNBRAKO SCREWS COST LESS THAN TROUBLE
UNBRAKO SOCKET SCREW CO., LTD · COVENTRY · ENGLAND

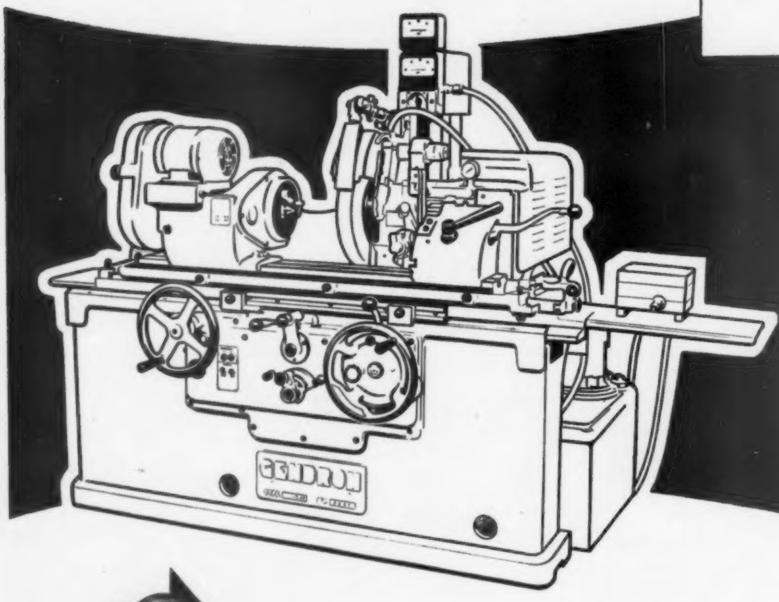
QUESTION –

How would you grind parts like this . . →



to make them fit parts like this . . →

WITH A CONSTANT CLEARANCE AND WITHOUT SELECTIVE ASSEMBLY ?



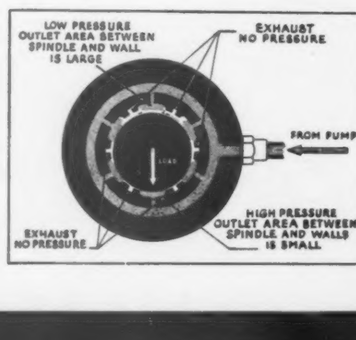
Stanley Howard answers . . .

With a GENDRON GRINDER fitted with E.A.M. Mating Equipment, which is capable of providing a constant clearance down to .00004" (1. Micron). Selective assembly of male and female parts is now completely obsolete as each component is AUTOMATICALLY MATED WITH AN INCREDIBLE STANDARD OF SURFACE FINISH

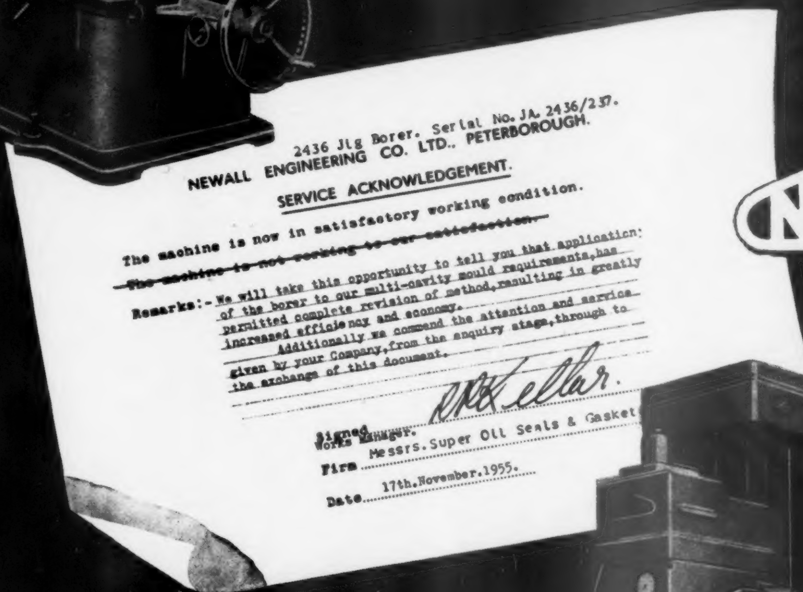
COME AND DISCUSS YOUR MACHINE TOOL PROBLEMS WITH US AND INSPECT THE VERY EXTENSIVE RANGE IN OUR NEW SHOWROOMS

STANLEY HOWARD L^TD
73 DEVON STREET
SALTLEY BIRMINGHAM 7
Telephone : ASTon 1275

The secret of the amazing finish lies in the 'fluid bearing' of the "GERRARD" grinding head incorporated in this machine. A sectional drawing of the 'fluid bearing' is shown on the right. Send for full details.



20 years of progress and service


2436 Jig Borer. Serial No. JA. 2436/237.

NEWALL ENGINEERING CO. LTD., PETERBOROUGH.

SERVICE ACKNOWLEDGEMENT.

The machine is now in satisfactory working condition.

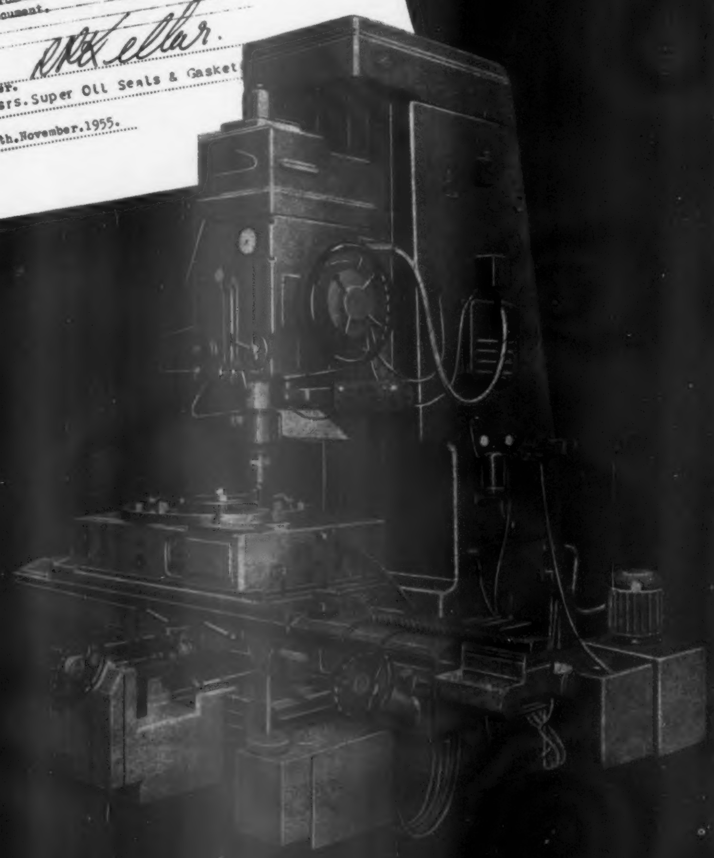
~~The machine is not working to our satisfaction.~~

Remarks:- We will take this opportunity to tell you that application of the borer to our multi-cavity mould requirements, has permitted complete revision of method, resulting in greatly increased efficiency and economy.
Additionally we commend the attention and service given by your Company, from the enquiry stage, through to the exchange of this document.

Signed RRKellar.
Works Manager.

Firm Messrs. Super Oil Seals & Gasket

Date 17th. November. 1955.



NEWALL

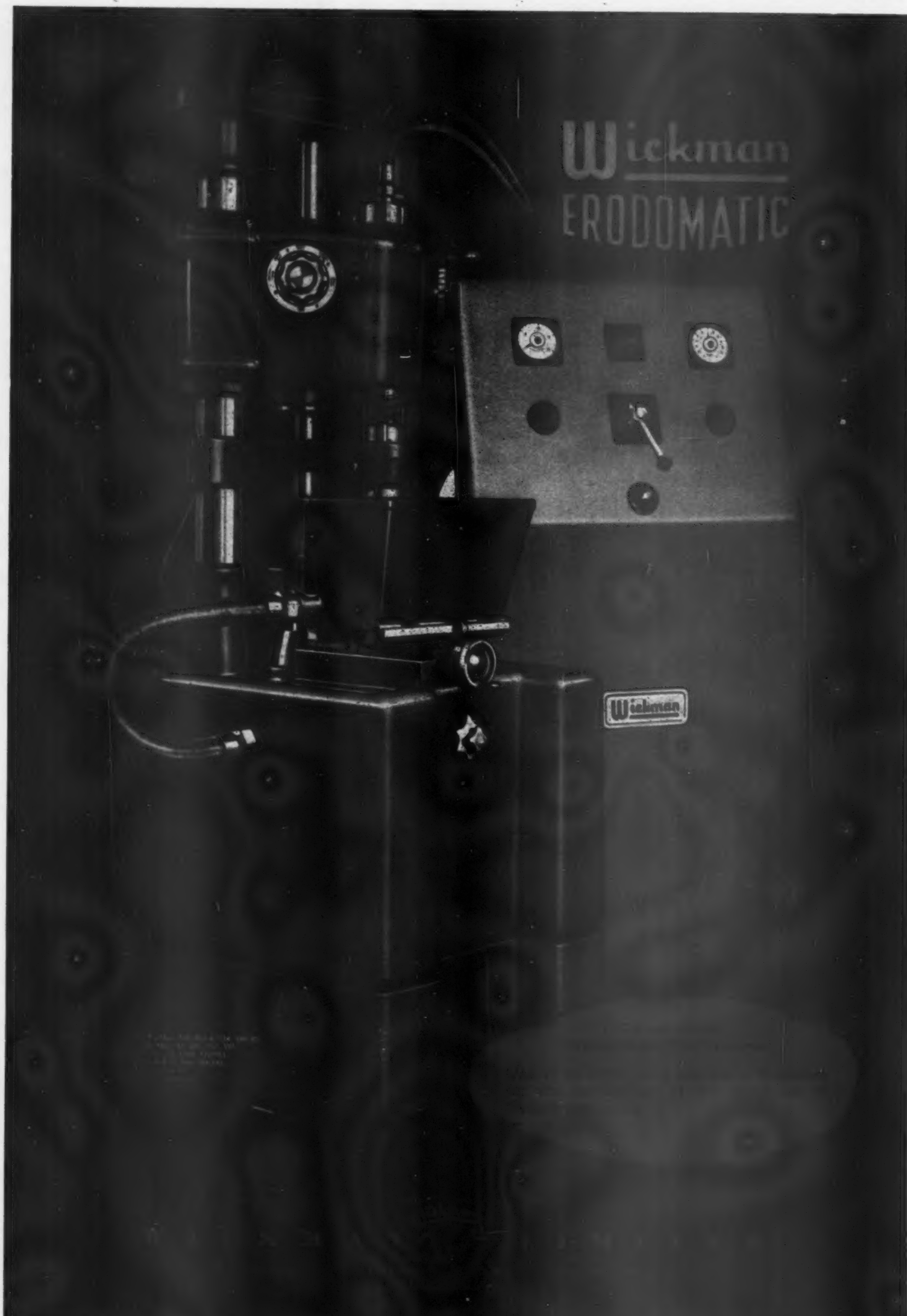
1956 heralds the twentieth anniversary of Newall jig borer production.

Throughout this period of development and progress the reputation of the Newall Engineering Company has been materially enhanced by the spoken word of satisfied customers and unsolicited references of the type reproduced above.

A combination of quality and long term service has resulted in the Company's present proud position as one of the world's largest manufacturers of Jig Boring Machines.

For full details of our production please enquire to

NEWALL GROUP SALES LIMITED


Wickman
ERODOMATIC
Wickman

The Institution of Production Engineers Journal
VOL. 35 NO. 6 JUNE, 1956

MACHINE TOOLS AND AUTOMATION

by H. P. POTTS, M.I.Mech.E.,
President of the Machine Tool Trades Association

THE visitor to the International Machine Tool Exhibition, which opens at Olympia, London, on June 22nd, will experience confirmation of an essential fact about machine tools, namely, that progress in their design and development is necessarily gradual and rarely, if ever, spectacular. The basic principles of machining, broadly speaking, do not change and the modern machine tool is the recognisable descendant of the first machines in which the principle of generation of true geometric form was embodied by pioneers such as Wilkinson and Maudslay.

It is this feature, involving positive tool control on a definite and predetermined geometric path, which distinguishes the modern machine tool, invented in England in the early eighteenth century, from elementary machines used as tools, some of great antiquity.

Most of the really significant developments in machine tool design have been concerned with, or have arisen from, this matter of tool control. When Maudslay invented the screw operated slide-rest and applied it to a lathe he had taken the first step towards the development of the fully automatic profiling lathe of today. Indeed, he had done more than that.

Earlier machines served to do little more than to provide power to magnify the possible achievement of a man's physical effort with a hand held tool. The embodiment in the design of a machine tool of a principle which might well be termed "self control" opened the way for every self-acting or automatic device adopted since then and culminating in "automation", within such fields of application of that term as are concerned with the cutting and forming of metal.

Informed writers on the subject of automation have been careful to point out that the only really new thing about it is the term itself and the production engineer, better than anyone, knows that every contribution towards higher and less costly production which his colleagues in the machine tool industry have made has constituted an added measure of automation and a step towards "full automation".

It is against this background that I propose briefly to survey some of the things we have done and are doing in the machine tool industry.

Continuous flow production has long been with us and the individual machines installed to comprise the production sequence to establish it, originally under the name "mass production", have, for a long time, been available from well established specialists in the various types of machine involved. It is worthy of note here that the structure of our machine tool industry has, during the present century, settled into a pattern of specialisation. At first and for a long time a machine tool maker would turn out almost any type of machine requested by a customer and in any quantities, from one off upwards. The economic and technical advantages of specialisation became recognised as the demand for machine tools became greater and more diverse, and concentration on one type, or a limited number of types, steadily became the standard practice. This is a pattern not peculiar to this country but is so eminently right for machine tool manufacture as to be reproduced in all the major industrial countries of the world.

This does not prevent, nor has it prevented, such proper degree of rationalisation of manufacture as is healthy for the industry. The practice has grown up, and must be intensified in the future, of collaboration with other specialists who must provide, in ever increasing quantities, commonly needed components which are identical on different types of machines or, in the more immediate connotation, are common to various systems and degrees of linking machining operations in the field of automation.

This cycle of collaboration, to be complete, includes the machine tool user. The provision of the means to enable manufacturers of the community's needs to bring better goods and services within the reach of an ever increasing public is a combined operation, involving the manufacturer himself, the machine tool maker and the specialist in a great range of ancillary equipment.

An outstanding example of the need for and eventual achievement of this joint operation is the automatic transfer machine, too well understood by readers of this Journal to need description. Originally designed and installed in England some thirty-two years ago, it was temporarily abandoned three years later, not because the designers' ideas were wrong, but because the means of executing those ideas in practice, particularly in the matter of control of operations, were insufficiently developed. The combined operation was not yet fully at work and the revival of interest in this logical development of automatic machining had perforce to await further experience and the necessary improvements in specialist products outside the machine tool maker's field.

Today, the automatic transfer machine is an accomplished fact in British factories. Several of our machine tool makers are specialising in its design and production, some on original designs and others under licence from abroad. There are other firms concentrating on the production of unit heads which are available to their fellow machine tool makers or to production engineers for the assembling of their own production lines or the modification or extension of those already existing.

A considerable number of these automatic transfer machines has been installed during the past several years. They represent the combined skill and enterprise of the production engineer, machine tool and engineers' small tool makers, the gauge and instrument producer, the mechanical handling expert and the electrical and electronics engineer.

A consortium is thus being built up to carry out the combined operation of which I have spoken. An example is to be found in the arrangements which have been established for consultation and collaboration between the machine tool industry and specialists in electronics. This has been greatly facilitated by the cordial co-operation of the Director of Guided Weapons and Electronics, Ministry of Supply. Upon his introduction, leading firms concerned with the design and production of electronic control devices for employment in the development of guided weapons have been visited by members of the Electrical Sub-Committee of the Machine Tool Trades Association's Standards Policy Committee. Following these visits, a confidential report has been prepared for the guidance of machine tool manufacturers on the manner in which, subject to security considerations, techniques evolved primarily for defence purposes can be applied to problems in the machine tool field. This is, of course, additional and subsequent to the close co-operation directly effected between individual machine tool makers and electronics specialists, some fruits of which will be seen at the International Machine Tool Exhibition.

The application of electronics to machine tools is, however, by no means the whole if indeed the major part of the machine tool - automation story, any more than is the in-line automatic transfer machine.

I believe that the major contribution, of which numerous examples exist, will comprise the linking of standard machine tools. The cycle can include, as automatic functions, loading, machining operations, transfer, gauging and inspection, adjustment of tool positioning as prescribed by the gauging operations, table positioning on co-ordinates, and so forth. Any number of these processes, involving any number

of standard machine tools, can be carried out on a fully automatic cycle or with manual intervention at one or more points in the cycle, according to the dictates of the predetermined economics of production. The automatic or semi-automatic controls can be electronic, electrical, electro-hydraulic, or mechanical.

This method brings automation into the field of limited production, a field proper to neither the continuous flow-line system with physically separated machine tools nor to the in-line automatic transfer machine. Even small shops will be able to consider the possibility of so linking their standard machines, eliminating expensive jigs and fixtures by the employment of the co-ordinate positioning system and of reducing inspection costs and scrap by in-built gauging and feed-back controls.

Notwithstanding the crippling limitations imposed by lack of floor space, the International Machine Tool Exhibition at Olympia will afford an opportunity of seeing an impressive number of exhibits illustrating this country's contribution to automation. I can here refer but briefly to a few examples which, however, will serve, I am sure, to show that a visit, or for that matter several visits, to the Exhibition will be well worth while to those interested in the subject.

Due, however, to the Exhibition space limitation at Olympia already mentioned, the exhibits concerned with automation cannot give a full picture of the industry's activities in this direction. It will readily be appreciated, for example, that a complete in-line automatic transfer machine could not be installed at an Exhibition such as this.

A standardised unit construction platen-type transfer machine is, however, represented by two and three station centre bed units, the loading and unloading ends incorporating platen cross-indexing and hoists with standard types of extension beds for mounting work heads and swarf and platen return conveyors. Mounted on this machine will be a selection of standard self-contained hydraulic feed unit heads.

Unit heads for embodiment in automatic transfer machines will also be separately shown by firms specialising in this product.

A machine tool which is basically a normal horizontal borer is controlled by an automatic co-ordinate setter, which comprises servomechanisms operating the horizontal and vertical slides of the machine which have traverses of 57″ and 42″ respectively. The slides can be set to any position by setting up the co-ordinates on dials on the face of the control desk. Six dials and clearly displayed figures are provided for each of the two co-ordinates to set up any required displacement from a pre-determined datum. The "dial-in" feature is appropriate to very short run production and tool-room work generally. For longer runs the slides can be set up by a card reader, also on the operator's control desk. Automatic clamping of the slides is provided when the desired co-ordinate position is reached. The wide speed range servomechanisms necessary for co-ordinate setting provide a convenient feed drive for milling operations, suitable controls for which are provided. Special attention has been paid to the problems involved not only of utilising the accuracy available in the electronic co-ordinate setting system but also of maintaining this throughout the life of the machine.

A similar control to that described above is applied to a vertical jig boring machine.

A milling machine is controlled entirely automatically from digital instructions on a magnetic tape prepared by a digital computor providing a rapid and economic method of producing small quantities of intricate parts, machined either from the solid, castings or forgings.

A 48″ vertical boring mill is fitted with built-in electronic profile turning equipment. The machine has been employed for the manufacture of tyre moulds, die blocks, hubs, fly wheels and cast iron moulds for glass ware. The control equipment is not an attachment but is built into the machine, which can be used as a standard or tracing machine at will, the change-over from one to the other being effected by push button control. The design of the profile turning equipment incorporates an automatic Bias Control so that any shape of template can be followed automatically without recourse to hand control.

The principle of linking standard machines is illustrated by the linking of a single spindle chucking machine and a multi-spindle chucking machine to perform various operations on one piece, the piece being automatically loaded and transferred.

The few examples I have quoted do not exhaust the British contribution and, in addition, many foreign contributions to our subject will be on show. This prompts one final word on the general subject of machine tools and automation. In my opinion its scope and significance are such that development cannot be subjected to narrow nationalistic confines. The country to benefit most by automation will be the one most ready to recognise the international nature of its multiple origins.

We have already seen that, in the form of the in-line automatic transfer machine, it began in England, where its progress was halted for a number of years. Its further development occurred abroad and was later re-established here. Similarly, progress in other manifestations of our subject will be internationally achieved and the British production engineer must not be denied access to what best suits his requirements because what he wants is of foreign origin.

No machine tool trade in the world is better organised and equipped to ensure this than the British. For many years British machine tool production and the importation of machine tools from abroad have gone hand in hand. A very high proportion of imports is in the hands of British machine tool manufacturers. Their Association embraces manufacturers and importers and their four-yearly Exhibition is an international one. Side by side with a production which, in spite of a desperate shortage of skilled labour, designers and technicians, is constantly increasing and advancing in original design, there is not only the importation by the British machine tool trade of the best obtainable from abroad but the manufacture in Britain of foreign designs under licence, matched in important instances by the manufacture of British designs abroad, even in the U.S.A.

So it is that whether a production engineer selects and installs a British or a foreign machine, it is an essential function of the British machine tool trade to provide him with that machine and all the services which should go with its provision. That is true of machine tools in general and the existence of this flexible and broad-based organisation will be a guarantee to the production engineer of the fulfilment by the British machine tool trade of his needs in the field of automation.

The Production Exhibition and Conference

Olympia, London

23rd/31st May, 1956

The Papers presented to the Production Conference are being published in this and subsequent issues of the Journal. This issue contains the following:-

SESSION I, 23rd MAY

"**Investing in Success**" by H. F. Spencer, Managing Director, Richard Thomas & Baldwins Ltd.

SESSION II, 23rd MAY

"**Investing in International Co-operation for Productivity**" by R. Grégoire, Director of the European Productivity Agency of O.E.E.C., and E. Fletcher, M.A., Deputy Director.

SESSION III, 24th MAY

"**Investing in Research**" by P. Spear, B.Eng., Director of Research, Rubery, Owen & Co. Ltd.

SESSION IV, 24th MAY

"**Investing in Automation**" by Dr. Alexander King, C.B.E., D.Sc., Chief Scientific Officer and Head of Intelligence and Overseas Division Department of Scientific and Industrial Research.

SESSION I

INVESTING IN SUCCESS

Mr. H. F. Spencer

by Mr. H. F. SPENCER,

Managing Director, Richard Thomas & Baldwins Limited,
Chairman of Council, British Institute of Management.

IT was said by Mr. Butler that we could double our standard of living in the next 25 years. The words were pregnant with a promise of a rich material future within the reach of tens of millions of people alive today.

Compared with pre-war, the material standard of living in this country — the volume of consumption — has risen by less than 1% per annum, that is, it is about 14% higher today that it was seventeen years ago. Bearing in mind that seventeen years ago we had unemployment and were not too well fed, and also that the population has increased by 7%, the volume of consumption has increased only insignificantly.

If we continue to advance at such a snail-like pace, in 25 years' time the volume of material consumption will have increased only by about 20% instead of the 100% which Mr. Butler pictured so rosily.

The possibility of doubling the standard of living 25 years hence presupposes an industrial efficiency and sufficiency over all our economy which may call for sacrifices in personal consumption at home — certainly great discipline in consumption — over the years ahead, rather than early increases in it. And the achievement of such industrial efficiency and sufficiency would be of infinitely more significance and value as an assurance of our survival in a competitive world, than as a measure of the satisfaction of personal desires at twice as well off a level in material environment.

To reach such a desirable end, we shall have to plan our capital investment programme, streamline our personal and public expenditure, and aim for more agreement on our main political objectives so that changes of Government do not necessarily involve radical changes in our internal economy. We also need new attitudes from organised labour and employer associations to productivity, wages and profits, and definite long-term decisive planning in education and scientific research.

A Formidable List

This is quite a formidable list of subjects calling for party and industrial foresight, agreement and toleration. It would mean a major change of our political, social and industrial life, and if we do not realise that at the outset, we shall not be able to bear with patience the frustration we shall endure in aiming for Mr. Butler's target.

Of course we all know that a standard of living is not wholly measured by the enjoyment of material possessions ; there are intellectual and spiritual lives where the criteria vary, sometimes inversely with material riches. An intensely spiritual life may see only temptation in the sensual environment of comfort and beauty, and the intellectual may contrive a supreme contempt for abundance of physical goods.

However, within the context of Mr. Butler's statement, and the meaning of this Conference programme, the standard of living we are considering is the material one, and I am asked to address you,

to the best of my ability, on the idea of what must we invest to redeem this promise which the present economic background may appear to make too colourful and scintillating.

It has been calculated that the net value — at constant prices — of fixed capital in the United Kingdom is not much above 110% of the 1938 figure, i.e. we have added only about 10% net to our total capital since 1938.

As to this capital equipment in general, there is still a great deal of industrial plant and buildings really obsolescent in the conditions of a world buyers' market. In coal mining, two-thirds of the coal is raised from pits sunk before this century began, and the Coal Board has stated that an 80% new industry has to be created by major reconstruction and new sinkings. In many of our older manufacturing industries, perhaps particularly in textiles, there is a heavy burden of obsolete equipment. At the end of the War, Lancashire had a higher proportion of old equipment in form of mule spindles and non-automatic looms than any of the other main textile areas of the world. The layout of our railway system and many of its main line termini were designed to meet the requirements of the Victorian age — not present-day conditions. Our road systems are little better, and in some cases bear the stamp of the Ancient Romans.

In my own industry — the steel industry — there are substantial quantities of finished products rolled to all intents and purposes according to nineteenth century practice on nineteenth century equipment, and the cost of modernisation involves very heavy capital expenditure.

Our agriculture can feed but half the population at the present not very luxurious level of food production. Whilst the numbers of tractors on British farms has increased four-fold since pre-war days, the fixed equipment on farms leaves still much to be desired. I am told that there are still 50% of farms without electricity and which are consequently hampered in using some of the latest farm equipment.

The building industry is responsible for half the capital investment work carried out in Britain. As an industry it is one of the largest employers of labour in the country, yet it has been said that the amount invested in contractors' plant throughout the industry is only about £100,000,000 in relation to a total labour force of 1,500,000.

By contrast, £150,000,000 would correspond to the capital cost of an integrated steel works employing about 10,000 men.

As to our social capital, out of 15 million dwellings, almost one-third date from 1870, or earlier, and over two-fifths of our schools were built before the turn of the century. Slums are not the only problem about housing. Much of the stock of houses is not geographically distributed to meet the industrial and social demands of today. We cannot omit from our consideration the immense obsolescent social capital we are up against. One great difficulty in siting a new works is the problem of labour supply and so often the key to an adequate supply of labour is an adequate supply of houses in the locality.

Nor can we close our eyes to the depressing and obsolete condition of many of our primary schools. Yet the facilities being planned for higher education in the technical field must be solidly based on primary education which, in turn, must be provided with teachers and equipment adequate to give the children a start.

We have not only to think of putting these things right, however, there are other things besides replacement, obsolescence and modernisation.

The Need for Fresh Investment

There is the need for fresh investment to produce new products. Since pre-war days there has been a growth of new products and new industries, such as antibiotics, petroleum, chemicals, plastics, guided missiles, etc. Science has brought nuclear power and automation, not only bringing new methods of producing electrical power or of repetition engineering, but opening up a new relationship between science and industry. Nuclear power and automation will have a revolutionary impact on industry — they will themselves also create outlets for capital equipment.

If we are to achieve success in modernising the obsolescent, replacing the worn-out and providing for new inventions and development, there lies ahead in the matter of investment, over the widest political, social, industrial and financial fields, on the part of the present and future Governments, a combination of virtues which the country would welcome, but which Governments appear unable to exercise, namely, clarity of thought, decisive planning, and determination in action.

It is not a case of utilising any one political party's ideology to reach the objective — it will be unobtainable without the use of all party policies and goodwill. We may need exhortation and voluntary restraint, intelligent banking and credit policies, and financial and material controls — all used with sensible and sensitive flexibility.

The First Essential

Britain is in economic difficulties ; it has found itself so over the last ten years. The first essential investment in success is good government — government which can wisely and bravely govern. The gravity of our economic situation calls for non-party or all party patriotic leadership—for unity, temporary sacrifice and strong determined government, with all parties pulling in one direction to get us first out of the trough and then lead us up to the heights.

The success we want is the achievement of a high and steadily rising standard of living, with a worthwhile job for everyone—a life full, interesting and satisfying for the mass of the people.

The investment we have to make in such success under present conditions, is likely to be akin to the investment of many of the pioneers—it is first an investment in foundations, buildings, constructing, equipping and organising. The early years are hard and claim their sacrifices. The profit is deferred—and often someone else garners it. So it may be with our investment in success. Some of us may not share in the return on it—but if we are resolute in carry-

ing out the right programme of investment, Britain's future will be assured.

Education for Management

Before we embark on a grand policy of wholesale reconstruction of factories, workshops, mines, transport, it seems to me important to make sure we can manage these organisations efficiently. If we are going to plan an intelligent investment policy over 25 years to rebuild our industry, we must plan an equally intelligent investment policy for the education and provision of scientists, technicians and managers in quantity and of calibre to keep us in the forefront of economic scientific development and production. Nuclear power and automation will make great demands on the supply of research chemists, technologists and technicians.

At the present time, three-quarters of our research effort is directed to military ends. In 1953 our Government research—civil and military—probably amounted to less than £250 million compared with the U.S.A's. figure of £1,000 million for Government and Government-sponsored research—not too much out of line I would say. But our expenditure on industrial research amounted to only £50 million compared with the U.S.A's. figure of £800 million spent by industry on non-military research.

The enormous amount of research, design and development work required for the production of atomic and hydrogen bombs and guided missiles gives some measure of the technical requirements of a peaceful age of nuclear power and automation.

The Government proposes the investment of £100 millions over five years in buildings for technical colleges and universities. Despite the fact that the number of students in science and technology at British Universities has doubled since 1938, and the number of technical colleges has also increased, we are far behind the United States and Soviet Russia. Compared with the United States' 22,000 engineers graduating each year and Russia's 60,000 we have only about 3,000 a year, and Soviet Russia has probably 70,000 other technicians passing out annually compared with our 8,000 a year. Britain is by comparison worse off for engineers and technicians than for pure scientists.

The Chairman of the United States Atomic Energy Commission recently predicted that, between 1950 and 1960, the U.S.S.R. would produce 1,200,000 trained scientists and technicians as compared with 900,000 in the U.S.A. and, we may add, perhaps 170,000 in the United Kingdom.

A Heavy Responsibility

Then there is the question of general management in industry. Industry is what management makes it, good, bad, or indifferent. Nothing happens in industry that cannot be made worse or better by management. Of course, I know there is a wider aspect to education, than education for industry; but it is snobbery to suppose that the most liberal education could not find a fulfilment of purpose in that part of our national life on which the material existence of millions of our fellow human beings depends, and in which all knowledge can be used. Management is no longer an accident of intuition, shareholding or favouritism. It is a heavy responsibility demanding education, knowledge, techniques, skills and experience. Excluding Russia, about which we have not too much knowledge, we do know that the greatest industrial nation on the earth is the United States. We do know that, in the main, her management standards are ahead of ours, and that there is an educational climate in the United States which ranks education for industrial and commercial management equal to education for any other walk of life. We accept the superiority of American management as to a great extent stemming from the superior standards of education and training demanded from all ranks of management from the earliest stage supervisor onwards.

If the United States, rich beyond the dreams of avarice in economic resources, lays such emphasis and stress on education for management, surely our need to do so is infinitely the greater.

There can surely be no doubt therefore that high in the priority list of investment in success is the provision of an adequate quantity and quality of scientists, technicians, technologists and general management. Investigation and research are obviously required into the questions of numbers, standards, teachers, buildings, finances and a score of other things. Plans and action are called for.

I have already mentioned the poor state of a good many of our capital assets on and around which our industrial activity is built and operates.

Here are a few figures which may be useful to us in considering the potentialities and limitations of future capital investment in success:

1. The net value of fixed capital in this country is probably around £35,000 millions, made up roughly as follows:-

Plant and machinery	21%
Industrial and commercial buildings ...	30%
Transport equipment	7%
Houses	42%

   One-quarter of the total capital assets dates from the Victorian or Edwardian eras.
2. Our gross national product amounts to about £16,600 millions.
3. In 1955 our gross formation of fixed capital amounted to about £2,800 million, about 17% of our national product was invested. This was a rather higher proportion than in 1948 and much higher than in 1938 when the gross investment in fixed capital was about 12½% of our national product.
4. Social investment included in our total investment is probably higher than the average of West Europe, and certainly higher than in the U.S.A. We have also a mass of accumulated depreciation to contend with—it exists physically in the form of outdated and outmoded buildings, roads, railways and plant.

Now the Government believes that one cure for labour shortage is to freeze off some of the capital investment projects. That can only be, however, a temporary expedient.

The Importance of Exports

One fundamental principle of our future survival is the maintenance of a high and increasing level of consumption demand abroad—in capital goods as well as consumer goods. We can only meet this demand from abroad if we can supply in competitive design, quality, quantity, time and price. Only if our capital equipment, scientific, technical, production and commercial management can supply, in competition, enough goods to overseas countries to pay for all we need to import to eat, and to use in our factories, with something over for overseas investment—only if that can be done—are we entitled to uncontrolled consumption at home. For it is obvious that the way to ruin is to consume what we cannot pay for. The cultivation and satisfaction of increasing export demand is vital. It is the spur to industrial efficiency.

Expanding exports should lead to increasing imports with more goods for domestic consumption. Expanding consumption means not only replacement of worn-down capital assets, but an expansion of such assets. Any stabilisation of consumption does not encourage new capital equipment; the best one thinks of is replacement. A falling consumption often leads to the worst state of mind, resulting in a failing demand for capital goods and machinery permitted to outlive its useful life without replacement—thus, a net disinvestment and a stagnating economy.

I have said that we can survive by maintaining a high and increasing export trade—that we can do that only if we are competitive in design, quality, quantity, time and price—obviously only if we have productive capital equipment and management which are up-to-date and efficient.

A quandary is to find the money, the labour and the facilities to bring our productive capital equipment up to a world competitive standard—not to mention its management. Up-to-date capital equipment is urgently needed to supply other capital equipment as well as consumer goods for export and home. And up to the point of at least balancing our imports with exports, we should give priority to exports.

There is not enough money available to satisfy all the claims on the national product. Labour is in short supply in this period of inflation, and facilities are lacking because capital investment in the past has been insufficient to meet the present day needs.

Yet our future rests on adequate investment in capital goods and quality management, in an increasing export trade, even at the expense of domestic consumption, and in the prevention and diminution of inflation. Restricting bank credits and hire purchase, raising purchase tax and making it harder to raise new money on the Stock Exchange, together with exhortation to save, may be useful instruments but do they not strike unevenly and unequally? And useful though they may be, they do not appear to entail, or result in, common sacrifice or common purpose. And can one say with any exactness their effect in time or quantity, on employment or unemployment, on export trade, on consumption at home, on saving, inflation or deflation? It is a case of hoping and wait-and-see.

Investment Financing

If we are going to "Invest in Success" we must know what we propose doing about investing in capital equipment, temporarily reducing our domestic consumption and permanently increasing our exports.

This great problem of investment financing—such a major item in this "Investing in Success" — is basically one of shares in the gross national product which can be split between :-

(a) Personal consumption;
(b) Government defence expenditure;
(c) Central and local Government expenditure on housing and the social services;
(d) Capital investment by the nationalised industries;
(e) Capital investment by private industry;
(f) Investment in private housing;
(g) Investment in stocks and works in progress;
(h) Overseas investment.

In 1954, about 29% of total gross investment went into new houses, social and other public services, and in view of the kind of stock of these in the country, it hardly seems a capital expenditure one could really cut. Additions to stocks and work in progess absorbed last year about 12% of our total investment effort. I believe that with first-class management, and a feeling that unnecessary stocks constitute a luxury which should not be tolerated in any well managed undertaking, a saving of £200 million could be effected on a national scale.

There is also an item of £200 millions a year of exported capital. We must try to keep this going. Last year the net outflow of capital from this country was reversed. In 1913, our overseas investments amounted to £4,000 millions and were more than 1½ times the annual value of the national product, and the net income from this overseas investment paid for 30% of our imports. Today, overseas investments are valued at about £2,000 millions equal to about one-eight of our annual current national product and the net income from them covers only about 3% of our total imports.

I am not too keen on cutting investment in the nationalised industries in transport, electricity, coal and gas which are vital parts of our industrial expansion. Maybe, they need some rephasing, but in general I do not see how we can cut down appreciably.

Defence Expenditure

There are two sectors of expenditure, however, which deserve the closest scrutiny. Government defence expenditure absorbs about £1,500 millions of our gross national product. Obviously, I cannot speak as a military expert, but in these days of atomic and hydrogen bombs, of political failure to implement our military policing of large slices of the world, and of America's indifferent behaviour to our interests and civilising influences in many parts of that world, one feels that there must surely be considerable scope for economies within the limits of an

expenditure of £1,500 millions on defence. No one seems greatly impressed with the value we are getting for this fantastic amount of money—particularly in the matter of quantity and quality of military equipment.

The Government, by its action on hire purchase, purchase tax and credit restriction, obviously believes that there can temporarily be some retrenchment in that great sector of personal consumption amounting to about £12,700 millions or 77% of the gross national product. It is open to the majority of working men and women to make a contribution to our present serious troubles, and to the realisation of the target of an increased standard of life, and that is by increased productivity. I define increased productivity as doing more, preferably a lot more, with a substantially increased pay packet, but at a reduced cost per unit of output. The employer should divide the benefit of reduced costs and higher outputs amongst the consumers and reserves and expenditure on modernisation, replacement, development and research.

Management must manage, of course, but it should be possible for management to exercise its function of managing and, at the same time, sit down with the Trades Unions and find a *modus vivendi* during this critical period of overcoming our difficulties and laying the foundations of a social system with greatly enhanced standards of living.

Productivity at the right level would solve the problems of domestic consumption—but if the industrial machine, equipment and human labour, cannot increase productivity and production at lower costs per unit, then voluntary sacrifices in consumption and saving, with purchase tax, hire purchase and bank credit restriction, are not quite enough to do the job alone. Control and allocation of materials, and maybe of labour and imports as well, some maximum price controls, plus incentives for personal saving, may be necessary to make a good start along the road to certain prosperity and to a higher standard of living by diverting production to exports and money to capital investment.

It is estimated that to maintain the nation's capital intact, we require an investment each year in fixed assets, at current values, of about £1,500 millions. But that does not get us any further forward. To advance, provide more up-to-date equipment, achieve greater productivity and build for the new age of nuclear power and automation, to build for new products, we need still another £2,000 millions a year for investment in fixed assets. Gross fixed investment of £3,500 million would be a 25% improvement on last year's figure of £2,800 million and put us on a footing comparable with, say, West Germany and Sweden.

To provide for such an investment calls for organisation, planning, controls, voluntary effort, temporary personal sacrifice of consumption and national goodwill.

We are faced with a world whose political, economic and industrial structure is being transformed. To achieve success our investment effort now must lay the basis for the production of the goods, services and know-how which the world is going to need in five, ten or twenty years hence. We are in danger of underestimating the radical changes taking place in the world around us and of the pace of development.

It is of importance and urgency that we build up our fuel, steel, and engineering industries and our capital goods industries in general.

The reason is obvious. Our own capital equipment in the capital goods industries themselves, in transport and in the consumer goods industries, badly needs bringing up-to-date. The developing areas of the world are going to demand greater quantities of capital equipment of all kinds. Our industries must produce the means of production for ourselves and for overseas.

As to steel, the country needs at least one more large integrated 1½-2 million ton steel plant to roll light steel plates, steel sheets and tinplates to feed our light engineering, electrical and other industries so that they can still further add to the great contribution to exports of vehicles, transport, electrical, and other manufactures.

After fuel, power, steel and engineering comes agriculture. It is in a bad way to help us properly. There is no technical reason why we should not feed a greater proportion of our population from our own land. It would be prudent for us to do so in view of the developments in some of the overseas food-producing countries. We shall be foolish in the extreme to base our increased standard of food consumption on imported foods.

Then come our archaic transport system, and the greatly needed increase in social investment.

All are possible with patience, temporary sacrifice, governing government, understanding between management and labour, and honest and sensible instruction of the public and good public relations.

Insistence on large-scale capital investment may seem inappropriate at the present time, especially as the volume of capital investment last year was largely responsible for the balance-of-payments crisis and a heavy fall in the gold and dollar reserves—at a moment also when the Government has ordered the nationalised industries to trim their capital investment plans, and private industry, too, is enduring Government-inspired propaganda which is not encouraging capital investment.

Nonetheless, despite the present diffculties, which cannot be minimised, capital investment of the right kind in the right quarters, properly phased, was never more necessary than now. Indeed, Britain is desperately in need of capital investment on all counts.

The present state of our capital assets as a whole is having—and will continue to have—serious effects on our competitive position in world trade. By 1914, we were surpassed in the level of our technology and in the efficiency of our production by both Germany and the U.S.A. Now, after the Second World War, we see rapid strides being made not only in North Europe and in Japan, but the establishment of first-rate modern productive equipment in Canada, Australia, India, Latin America, and China, to say

nothing of the tremendous advance of the Soviet Union. Competition in world markets grows apace.

What real explanation can there be of the fact that America can compete with us for export markets with a wage level at least three times ours, other than the fact that the horse power available to each worker, and the productivity of each worker, are far greater than in this country? There is proportionately a far greater investment in scientific research, efficiency studies, product design and quality control.

The rate of growth of an economy is governed by the proportion that economy devotes to investment. This is being formidably demonstrated by Germany and the Soviet Union, both of whom invest nearer 25% than 20% of their national product. As a result, the rate of growth of industrial production in West Germany and the Soviet Union has, in recent years, been of the order of 10/15% per annum compared with an annual rate here averaging 5%.

We shall remain economically weak and susceptible to shocks like the recurring ones of the past ten years until we put our industrial capital equipment in fighting trim. Until our economy and financial reserves are in a sounder condition, we may have to plan the rate of our investment at a lower tempo than we would like, and in any case it must be limited by how far the people are prepared to forego luxuries and, perhaps, some necessities temporarily in order to achieve the more luxurious standards for which we are aiming.

The enormous volume of exports we must achieve in the future to raise our standard of living to any great extent must be distributed on the widest possible geographical basis. Great changes are imminent in the products we shall be called on to supply on competitive terms. Countries like India and China are about to make leaps in technique corresponding to centuries of progress in the West . They will call for something better in transport than buses discarded by our cities here and something more up-to-date than secondhand machinery. The new nations springing up are demanding that their new industries shall be equipped with the finest plant, and many hitherto under-developed areas are about to move from the most primitive technical level into the age of automation and nuclear energy.

Development in these countries will, of course, be uneven. Giant plants embodying the latest scientific knowledge will exist side by side with the village craftsman and the wooden plough. But the new techniques cannot be arrested, and how are we to meet the new demands on us if we ourselves are not equipped properly?

The world is going through something of a political revolution, and undoubtedly this will have a big influence on the future of world trade in which we are so vitally concerned. At the same time, we are on the threshold of a technical revolution in industry which will surpass the industrial revolution of the eighteenth and nineteenth centuries, both by virtue of its pace and its widespread character. Our share will depend on the volume and rate of our future investment in physical assets and on our scientific, technological technical and industrial management progress.

What can you and I do about all this? Well, we can consume less unessentials, spend less, save more, waste less, and work harder. If the whole occupied population of 24,000,000 people do those things we shall surprise ourselves and shock the world with the magnitude of our national advance, and the personal happiness we shall experience from the acceptance of such responsibilty.

We shall truly be " Investing in Success ".

Film Show on

MATERIALS HANDLING TECHNIQUES

held at the College of Technology, Birmingham.

A SERIES of Materials Handling films was shown to an audience of nearly 200 members of the Institution, at the College of Technology, Birmingham, on 27th March. The meeting was arranged by the Materials Handling Sub-Committee of the Institution and its Chairman, Mr. A. G. Hayek, presided after an introduction by Mr. T. B. Worth on behalf of the College.

The first film shown, " A Case for Handling ", was one made by the British Electricity Development Association and showed the improvements achieved in a typical engineering works as a result of improved handling techniques. After the showing of this film the Chairman told the audience of the work done by the Materials Handling Sub-Committee and indicated some of its future activities. Mr. Hayek appealed to the audience to help in the Case Study programme by submitting to the Committee some studies on the results of improved handling techniques, for publication in the Journal. The Case Study Group of the Sub-Committee would be glad to assist members in preparing such studies.

The second film was " Layout Handling for Factories ", a film on the principles of improved inter-process handling. The third film was of American origin, entitled " Pacemakers for Industry ", and dealt with the conveyorisation of American factories.

After the showing of the films there was a lively discussion on the training of Materials Handling Engineers and on their place in Works Management. There were also several suggestions from the floor on future work the Materials Handling Sub-Committee should undertake.

The meeting carried on well after the scheduled time, and the audience requested that further film shows and discussions of this type should be held at regular intervals.

SESSION II

INVESTING IN INTERNATIONAL CO-OPERATION FOR PRODUCTIVITY

by Mr. ROGER GREGOIRE, Director of the European Productivity Agency of O.E.E.C., and
Mr. EDWIN FLETCHER, M.A., Deputy Director

Mr. Roger Grégoire

Mr. Grégoire was born in 1913. His father was Professor of Surgery at the University of Paris, and later became President of the French Academy of Surgery.

At the Sorbonne the young man obtained degrees in Law and Literature; at the same time he secured a degree in Political Economy at the Ecole Libre des Sciences Politiques.

After spending two more years at the Ecole Libre, Mr. Grégoire was admitted, in January, 1948, to the Conseil d'Etat—a French government consultative body for constitutional, legal, and administrative questions. Here he became rapporteur of the newly-created Cour Superieure d'Arbitrage entrusted with the handling of industrial disputes. Before being mobilised in September, 1939, he was appointed to a committee studying administrative reforms and in this capacity made an extensive study of administration in Bordeaux.

Taken prisoner in 1940, Mr. Grégoire took charge of the camp "university", where he lectured on law, political economy and public administration.

Since his release in 1944, Mr. Grégoire has had a busy and kaleidoscopic career, including inter-allied liaison work for the Ministère des Affaires Etrangères and promotion to Maître des Requêtes at the Conseil d'Etat.

In 1945 he became Director of the Fonction Publique, a body existing to study the workings of the French Civil Service. He found that in addition to administrative procedure he had increasingly to study training, human relations, psychology and techniques of work.

The fruits of this study and reflection are to be found in his book "La Fonction Publique", in which he not only analyses the problems which beset public administration but suggests some solutions.

Mr. Grégoire's activities were not limited to France. He was asked to advise on French administration in North Africa and also went to the U.S.A. on a United Nations Mission to study problems of personnel administration. In 1947 he was appointed a member of the Supervisory Committee of the Institut International des Sciences Administratives. In 1951 he joined the International Civil Service Advisory Board and in 1953 was nominated Professor at the Collège d'Europe in Bruges.

With this national and international background of public administration, he was appointed Deputy Director of the European Productivity Agency in January, 1954. On 1st April, 1955, he became Director.

In November-December, 1955, he spent several weeks in the U.S.A. Dr. King, C.B.E., Chief Scientific Officer of D.S.I.R. and Chairman of the E.P.A.'s policy committee accompanied him, and together they contacted U.S. administration, Universities, industries and trade unions.

Mr. Edwin Fletcher

Mr. Edwin Fletcher was appointed Deputy Director of the European Productivity Agency by the Council of the O.E.E.C., in 1955.

Mr. Fletcher was in charge of the British T.U.C. Production Department from its formation in 1950 until his secondment to E.P.A. He is an M.A. of Cambridge University, where he read Economics, and is also an Incorporated Accountant.

He first joined the T.U.C. in 1944 when the economics side was expanded to develop plans for post-war reconstruction. Previously he had held various practical jobs mainly in the engineering industry. At the time of joining the T.U.C. he was Chairman of a large West of England branch of the Transport and General Workers Union. In 1947 he was put in charge of the T.U.C. Research and Economic Department.

As officer in charge of the T.U.C. Production Department, he was responsible for developing the extensive scheme of technical training in production subjects now available to British Trade Union officers. He has acted as secretary of the T.U.C. Production Committee (which also supplied the basis of the Trade Union side of the British Productivity Council) and the T.U.C. Scientific Advisory Committee.

Between 1948 - 1953 Mr. Fletcher was a member of the Advisory Council of the Department of Scientific and Industrial Research and Chairman of its Industrial Grants Committee in 1952 - 1953. He was one of the original members of the Committee on Human Relations set up under the joint sponsorship of the Department of Scientific and Industrial Research and the Medical Research Council (1953 - 1954). He was a member of the Ministry of Labour Committee on the Training of Supervisors which reported in July, 1954.

Mr. Fletcher was also a member of the British Institute of Management Trade Union Advisory Committee, the Advisory Committee of the Cranfield Work Study School, and the British Standards Institution Committee seeking agreement on Work Study terminology. He has been a frequent contributor to conferences of such organisations as the British Institute of Management, the Institution of Production Engineers, and the Institute of Personnel Management.

DURING the war and in the difficult years which followed, our very lives depended on co-operation—co-operation with allies, co-operation between industries and firms short of manpower and starved of raw materials and fuel, co-operation between every citizen. To-day industry no longer labours under such duress. Its wheels turn with greater freedom and with greater independence. The spirit of competition which was forced to lie dormant during the fight for survival is once again the driving force behind home and foreign trade. Such facts which apply to Western Europe as a whole are particularly true of British industry with its great dependence on markets overseas.

Nevertheless a great deal of useful co-operation has survived the transition from war to peace. Industry by industry, the contribution of Research Associations and Trade Associations has won increasing recognition. The technical operations of the National Union of Manufacturers and the wider activities of the British Productivity Council cover many industries. Regional activities such as the Bristol Work Study School of the Engineering and Allied Employers' Association are particularly significant. A more unusual kind of co-operation is being displayed by individual firms such as Imperial Chemical Industries Ltd. which are giving direct technical assistance—based on their work study experience—to other firms, even in the same line of business.

A measure of co-operation has therefore become part and parcel of competitive industry. Much of it would have been quite impossible in the '30's. It has emerged not in response to theories but as a positive endeavour to solve immediate difficulties.

In face of overseas competition it is perhaps natural that co-operation with rivals abroad should not appear so attractive as co-operation with rivals at home. Yet is the one kind of co-operation so basically different from the other? The objective is to acquire and exchange information and ideas about industrial development, in the context of competitive industry; and the wider the field, the greater the potential rewards. Reluctance to take advantage of available opportunities for exchanging ideas may be interpreted as a sign of weakness—a fear of inability to compete. Is such timidity a useful characteristic in the face of industrial competition?

Just as the individual progressive firm will do most of its research itself, for competitive reasons, but will leave some to co-operative research associations, so on the international scale there is some development work which must be kept private, but also some which can be done in common and some experience which can profitably be exchanged.

Many prominent British firms have their own international contacts and associations and derive great benefit from them. Others take advantage of whatever information is available. The Anglo-American Council on Productivity, and its counterparts in other countries, made a deliberate and sustained effort to provide an exchange of information and ideas across national frontiers. The widespread demand for A.A.C.P. reports—more than half-a-million from a wide variety of industries—is an indication of the reality of the need. Britain received, and continues to receive, great benefit from her co-operation with the other side of the Atlantic, but our American friends have often pointed out that in the process of exchanging "know-how" the giver benefits as well as the receiver.

In London—the heart of the British Commonwealth—it should not be necessary to labour this point. The United Kingdom is by tradition the great provider of capital and skill to all the Commonwealth countries; and as her partners in the Commonwealth grow stronger economically and compete more directly with her, she continues nevertheless to invest in them and to co-operate in their development, confident that she too will share in their increasing prosperity. Prosperity, in fact, like peace, is indivisible. The real interest of all of us lies in fostering steadily expanding production, to the accompaniment of increasingly abundant purchasing power and expanding markets in all countries. To this end the best of new ideas, whether from within the firm or from abroad, must be fully utilised to keep in the forefront of competition for new markets.

This Paper is directed at certain European aspects of this world-wide problem. It indicates that a measure of international co-operation in industry is both possible and worth while; that at times, indeed, it is an extravagance to do without it. There is no need to argue this case on sentimental grounds, or to rely on the recognised political necessity for closer association among the peoples of Europe for

there are now enough facts, taken from the three years' experience of operating the European Productivity Agency, to demonstrate that " International Co-operation in Productivity Pays."

Before discussing some of the activities of the E.P.A. in facilitating the exchange of information, experiences and ideas, and in helping O.E.E.C. member countries to step up the pace of their industrial and agricultural development, the general problem of Western Europe should be examined.

The European Problem

First, where does Britain stand in relation to the rest of Europe? British industry is in high repute throughout Europe where the efficiency of its financial services, management techniques, labour relations and trading and marketing arrangements is appreciated. British productivity is relatively high, though not uniquely or uniformly so, and Britain has much to give in co-operating with the rest of Europe. But the days have passed when such traffic was essentially all one way. In the basic industries of agriculture, building and transport, in the now very large and increasingly important tourist industry, in training methods, in automation even, there is much to be learnt and much valuable guidance is already coming to Britain from across the Channel. The underlying fact is that, in certain European countries, overall productivity levels are rising more rapidly than in the United Kingdom.

What of the productivity of Europe as a whole? During the immediate post-war years, the index figure of industrial productivity rose steeply from a very low level, by as much as six per cent. annually in some countries, though the rise is now less marked. Europe received during this period a significant amount of international assistance and we must acknowledge particularly the generosity of the United States in giving both financial aid and technical information of the kind found in the Anglo-American Council on Productivity reports. The immediate justification for this aid was, of course, the rehabilitation of Europe after a devastating and exhausting war. But the question of war damage repair may sometimes obscure the longer-term realities of the situation. The superiority of the United States' position is not so much a war phenomenon as the cumulative result of a series of annual increases in productivity. Since the turn of the century, productivity in the U.S.A. has been rising at a rate roughly double that of the United Kingdom.

The two ratios have frequently been discussed by Sir Ewart Smith and others who have continually stressed the importance of paying greater attention to U.K. industrial productivity. Their views have received widespread recognition but insufficient emphasis is being put on the fact that at the current rates of productivity increase, the transatlantic differential, far from being reduced, is actually increasing.

Comparison with the Soviet Union is equally significant and offers just as little ground for complacency. A few years ago that country lagged farther behind us, than we did behind the United States; but recently Soviet productivity of labour was noticed to be increasing at a high rate—seven per cent. in 1954 and eight per cent. in 1955, according to the estimates of the Economic Commission for Europe* Mr. Hugh Gaitskell has recently stated that the Soviet Union's national income is growing more than three times as fast as that of the United Kingdom. The records of a series of atomic explosions and, perhaps even more, the unexpected appearance at London Airport of its TU-104 twin-jet airliner, are at last shaking us out of our reluctance to accept the reality of the Soviet Union's growing competitive power.

What of the future economic backing for European civilisation? From the short-term point of view this depends on making the best use of existing capital equipment. Seen as a long-term problem, it depends also on rates of investment, both physical and educational, and on the prosecution and application of scientific research.

Consider rates of investment in physical assets. The following table could not be clearer in its implications, in spite of national reluctance to accept the complete accuracy of such estimates. *Net* fixed investment indicates the extent to which a country is adding to its accumulation of factories, machinery, etc. The United Kingdom has consistently been doing this less than other Western European countries. Comparable figures for Russia are not available, but the E.C.E. has shown that *gross* investment is much greater there, in relation to national income, than in most western countries.

ESTIMATED CAPITAL ACCUMULATION IN WESTERN EUROPEAN COUNTRIES†

Net fixed investment as percentage of net national product

Country	1950	1951	1952	1953	1954
Norway	20	17	19	21	22
Finland	22	21	24	20	21
Austria	13	16	14	13	15
Western Germany ...	14	14	13	14	15
Switzerland	—	—	—	—	14
Netherlands	11	10	11	11	13
Denmark	12	13	13	13	13
Italy	11	11	12	12	12
Sweden	10	9	9	10	11
Greece	15	10	9	8	10
Turkey	6	7	9	9	9
France	7	8	7	7	8
Belgium	8	6	6	6	6
United Kingdom ...	5	5	5	6	6

Note.—Countries are listed in descending order according to the rate of capital accumulation in 1954.

As for educational " investment," a recent White Paper on Technical Education gave information on the relative supply of technical manpower in the United States, the U.S.S.R. and Western Europe. The statistics available are, as in the case of physical investment, not ideal for making international

* Economic Survey of Europe in 1955—E.C.E., Geneva, 1956. p.168.

† Economic Survey of Europe in 1955—E.C.E. Geneva, 1956. Table 22, p. 44.

comparisons. Nevertheless, the differences between countries are so great that they must be regarded as significant. In 1954, Great Britain produced 57 university graduates in engineering and other applied sciences (or holders of diplomas awarded in universities) for every million of its population. The United States had 136 engineering graduates per million population that year. Admittedly, a substantial proportion were graduates whose qualifications were no higher than those of many British holders of Higher National Certificates, but many of them proceeded to take higher degrees.

Russia, according to a study made by a Harvard professor and accepted by the United States National Science Foundation as the best available in the circumstances, is quoted (apparently with confidence) by the White Paper as producing annually 280 " professional engineers " for every million of her population. These are people who have taken 5½-year courses at specialist institutes where standards are said to be high.

Similar comment could be made about technical grades below that of graduate.

Current shortcomings in the promotion and application of scientific research have been the subject of much talk in O.E.E.C. Member countries and improvements have been put into effect. In the United Kingdom, government support has recently been increased as far as overall financial stringency would permit. But few can regard the present allocation of resources as sufficient to sustain the necessary growth of Western European countries, in view of the fact that the future ability of so many important industries to compete depends almost entirely on their being in the foreground of technological development.

Nations must advance or suffer decline. The warning signs just mentioned demand exceptional efforts from all of us in Europe and a realisation that traditional or insular methods are proving insufficient. There should be a willingness to review existing methods, to consider new methods of stimulating industrial progress and to make the best co-operative use of our productive resources. If the task is beyond us, we shall be left further behind by our more prosperous American neighbours, and caught up rapidly by those in the East from whom we have so far felt little pressure of competition.

A special aspect of the European productivity problem is that of under-developed areas. One of the most challenging tasks for all who are working to raise productivity is that of getting the best out of areas, such as some in Southern Italy, in Greece and Turkey—perhaps also in Northern Ireland and Northern Norway—where, through no fault of their own, the inhabitants lack the resources to join fully in the prosperity of a modern industrial society. These areas constitute a drag on economic progress and a source of social instability.

But if Europe has some relatively ill-favoured areas, it has some of the finest industrial units in the world. Continental workers possess a high degree of technical skills of all kinds. An important part of Europe's productivity problem, therefore, consists in improving the communication of ideas and techniques so that waste and inefficiency are not tolerated through ignorance of better principles and practices. This is one of the greatest contributions an international organisation can make towards raising productivity.

The problems we have outlined here are familiar ones and are certainly not of recent origin. What is new is the spirit of determination in which, since the war, the task of putting the economic affairs of the whole of Europe on sound lines is being handled.

Measures which even up to 1939 would have been judged impossibly idealistic and grandiose are now undertaken as practical everyday tasks. The fact that seventeen Governments confer within the O.E.E.C.—an organisation which has had consistent support from successive United Kingdom governments ever since its inception in 1948 is perhaps the most striking embodiment of this new determination to co-operate in a drive towards prosperity, by progressively freeing international trade, by encouraging sound monetary and economic policies on the part of Governments, and by stimulating industrial and agricultural production.

Productivity and the Individual Firm

The problem of industrial Europe is the sum total of the problems of a multitude of individual firms. While Governments may play their part in encouraging the allocation of sufficient resources for capital investment, research or education, those actually engaged in industry must make the most of the *available* resources of capital, materials and manpower. This is largely a challenge to management, affecting everyone from the foreman up to the top executive. In most industries, the difference between the most efficient and the least efficient firms suggests that more attention to some aspects of management could still pay big dividends. Many firms would find it possible to increase productivity in the complexity of managerial processes—by taking, perhaps, fuller advantage of the most modern techniques of budgetary control, cost accounting, quality control or market research, for example. It might be that a firm cannot maintain well-planned production targets—a sign that something may be wrong with the healthy state of " human relations " so essential to the success of all other measures to raise productivity. It might be that a simple change would have unexpected possibilities, as happened in the Birmingham factory where an improvement in the lighting, carried out overnight, increased output by ten per cent. Such cases are so common that nobody should be too sure that nothing of the kind is possible in *his* factory. But whether we are considering simple improvements in a small plant or a major re-organisation of production in a large and complex industry, *something* can always be done to raise productivity, providing that the conviction exists—as it so notably does in the United States and in the great majority of firms in Britain—that " there is always a better way," the slogan of the British Productivity Council.

Are We Learning Enough From Each Other?

The difference between the most efficient and the least efficient firms is often a fairly good indication of what can be achieved by increased productivity. While full acknowledgement must be made to the intellectual lead given by economists, sociologists, scientists and all engaged in research, it is not every day that they are able to make *really* new discoveries in the field of productivity. Nor is it to be expected that Government-sponsored productivity organisms can be ahead of the leading firms in industry—quite the contrary. The high road to success for those whose performance is average or less than average, is rather to get new ideas from the most highly developed firms. Many participants in the Anglo-American Council for Productivity teams found that one of the most useful parts of their exercises was a tour of firms in their own industry in the United Kingdom. The same principle is acknowledged in the British Productivity Council's circuit schemes and, of course, in the many private arrangements in industry.

The more enterprising of us are not limiting our attention to this country. The recent visits to the French National Railways, not only by Sir Brian Robertson but also by a team of railwaymen under the auspices of the E.P.A., and the adoption by British Railways of the French system of high voltage electrification which enables immense savings in material to be made, prove this point. There are other industries on the continent of Europe which deserve our attention and which we might do well to study. Some of us have no doubt been doing some hard thinking about the high sales of the Volkswagen; or about the Renault factory which the U.S. Vice President of the Ford Company assessed to be "more highly automatic than anything we have got in the United States in the automobile business" and which arranged its transformation smoothly and without labour difficulties. But do we know all that we should about the successful techniques for winter building in Sweden? Or the present-day training arrangements for apprentices in Germany? Or the training of trade union officials in Holland and Belgium? In 1956 British industry is in a good position to learn about these and other successful continental developments. They can expect facilities to be offered them which never existed before, in a new spirit of international co-operation which is fostered by the countries of the O.E.E.C. and is more of a reality than is sometimes appreciated on this side of the Channel.

The European Productivity Agency

From what has been said above it is clear that the efforts of individual firms, trade associations, or the Government will not suffice to bring to industry the full benefit of exchanges of experience *across national frontiers*. An international organisation is needed to make continuous comparison between the best practices in all countries and to assist and accelerate national endeavours—by rapidly providing technical information from Europe or from the United States, by making available specialist teachers on industrial subjects, by arranging for exchanges of experience among people working in similar fields. An outstanding example of what can be achieved in this way is the European plan now being developed for research into the production and industrial uses of nuclear energy. Another is the proposal for joint research into metal fatigue failure. Indeed, in both these instances it is doubtful whether any single country in Europe could afford research on the scale necessary, and for European countries the addition of such international projects to national endeavours is the only way in which they can keep abreast by their own efforts of the progress being made in the United States and the U.S.S.R.

It would not be desirable to have an international organisation intervening too directly in the affairs of firms or of Governments in its various member countries. Such an organisation should be a catalyst helping people to help themselves. In fulfilling this role two activities are most essential—training and information. An international organisation should be able to draw on the services of the best available teachers and consultants, and should also be a clearing house for exchange of information and experience and a source of authoritative technical information.

The European Productivity Agency has been trying, since its inception in 1953, to meet the need for an international organisation of this kind in the field of productivity.* The Governments of the O.E.E.C. countries have recently confirmed that the three-year trial has been a success and that the work of the E.P.A. is sufficiently important for it to receive their regular annual support.

As a part of the O.E.E.C. the Agency necessarily pursues a policy in harmony with that Organisation's other activities directed towards freeing European trade and developing industry. Under the general guidance of the O.E.E.C. Productivity and Applied Research Committee, the Agency maintains a small secretariat of about 45, with clerical and secretarial help, at the O.E.E.C.'s headquarters in Paris, and engages in addition the services of specialists, on a consulting basis and for as long as they are needed, to carry out its various projects. In addition to the guidance on policy given by the O.E.E.C. Committee, the Agency also enjoys the services of an advisory board consisting of prominent men in industry, agriculture, and the trade unions, who are chosen for their personal qualifications and not as national representatives. The United Kingdom's present representatives on this Board are Sir Percy Mills and Mr. James Crawford; originally they were the late Sir Wallace Akers and Mr. Jack Tanner.

The O.E.E.C. laid good foundations for the work of the E.P.A. by encouraging all member countries to set up national productivity organisations. It is through the latter that the E.P.A. exerts its main influence, and more and more of its work is now being done at the request of national bodies. Certain of the Agency's activities are on a continuous basis, but as will be seen later in the Paper, much of its work is done through more or less short-term, self-contained

* For an account of the early development of the E.P.A., see "The Story of E.P.A." by Dr. A. King in the September, 1954, issue of "The Manager."

projects, each handled by its own specialist staff engaged for a finite period. A project is started if a minimum of five countries support it; in practice, projects are backed by eight or nine countries on the average, and are thus truly international operations.

By far the greater part of the E.P.A.'s work is intended to improve the efficiency of industrial units in the immediate future. Examples of such activities are its providing management consultants to hold seminars and create interest in modern management techniques, work study, quality control, accident prevention and other problems of production and distribution; its encouragement and assistance given to the free European trade union movement for increasing competence in dealing with detailed matters of industrial development. E.P.A. help to universities and schools of management training can have immediate results inasmuch as it is directed at alleviating their present difficulties, but the ultimate aim is to encourage them to increase the scale of their activities and adapt them to the requirement of the future.

This is not the place for a detailed review of all the Agency's activities. The selection which is given below, taken from its current programme, gives some idea of the kind of work that is going on.

Management Education

Most European countries have recognised that it is necessary to pay far greater attention to management education at all levels so as to face up to the realities of the industrial challenge. They are short of teaching institutions, teachers and material for education in business management, and have therefore found it impossible to expand management education programmes fast enough. It has been hard enough to provide the buildings: it is proving even harder to provide the teaching staff and *expertise* with sufficient speed. Even in the United Kingdom appointments to chairs of business management have been delayed for want of suitable applicants.

The E.P.A. has been asked to help and is making arrangements for the regular exchange of programmes, teaching material and case studies between European countries. There is a great shortage of European teaching material, and in the past there may have been too much reliance on literature from the United States. Details of curricula, teaching methods and material and the services of several experts will soon be made available by the Agency to teaching establishments, whether they are run by universities, professional associations or other qualified bodies; an operational unit has been established within the E.P.A.'s management division to deal solely with this matter. This important programme will be carried out by a B.I.M. specialist who will bring to the Agency his experience of British management training and who will in the course of his European activities, widen his own knowledge and experience.

In the absence of adequate European facilities for post-graduate training, some European trainees are being sent to United States universities. They will become teachers in European management schools, and organise special courses to enable teachers in Europe to increase their mastery of business management subjects. At the present time 56 E.P.A.-sponsored future teachers are attending a number of United States universities, including Harvard, for a period of twelve months.

The E.P.A. is also making a continuous study of the needs of universities and other training institutes, and approximately once a year related subjects are discussed at an international conference so as to ensure an effective exchange of views between countries. The first of these was at Henley-on-Thames in September, 1953. It is from the recommendations of this conference that several of the Agency's business management activities have stemmed.

Management Techniques

Apart from this fundamental work designed to improve educational facilities, the E.P.A. is active in spreading knowledge of the most modern techniques of management in response to the expressed needs of O.E.E.C. Member countries by means of team visits, seminars and courses. When a number of countries have requested a specialist in a certain technique, a consultant, American or European, is appointed and a programme arranged to suit national requirements and to stimulate the practical application of the technique in question. Follow-up activities are in the hand of individual countries and are undertaken by local specialists, though the E.P.A. assists wherever possible, particularly by training *trainers* and by providing lecture notes and other matter which may form the basis of pamphlets and brochures. Subjects dealt with include cost accounting, budgetary control, variety reduction and industrial safety. In the case of quality control, such action was followed by a decision to form independent S.Q.C. associations in Member countries, stimulated by a European international secretariat which the E.P.A. is prepared to assist for a limited period (this should be noted as an example of the absence of empire-building in E.P.A. activities).

On the subject of variety reduction, the E.P.A. maintains a particularly close liaison with the British Standards Institution. At the request of that body, an E.P.A. consultant, Professor Martin, Professor of Management Engineering at the Rensselaer Polytechnic Institute, New York, whose presence in Europe was requested by several countries, will undertake seminars in several United Kingdom industrial centres during October and November this year. (Professor Martin is also contributing the paper " Investing in Simplification and Standardisation " during the present Conference.) Scandinavian countries have been particularly interested in this important activity, and a regional organisation for variety reduction is emerging. A project is now being developed on " operational ratios " intended to facilitate inter-firm comparison: important preliminary work was undertaken by the British Institute of Management, which in turn will be assisted by this project.

Distribution

Wholesaling and retailing already account for about one-eighth of the total labour force of O.E.E.C.

countries, and such services may well increase as industrial production grows. It is useless, and even dangerous, to concentrate on efficient large-scale production without paying similar attention to distribution. Production increases depend on markets, and more attention has to be given to what the customer wants, for failure to determine this fact precisely can be all the more disastrous when it results in a waste of production capacity involving expensive and highly-mechanised plant. To avoid this kind of risk we must get to know systematically the customer's likes and dislikes. It is no accident that the United States, the country with the highest output per head, is also the one with the greatest expenditure per head on market research.

The E.P.A. recognises that insufficient market research is done in Europe, and has so far contributed to a better understanding of the subject by making studies of market research in Europe and in the United States, and by sponsoring a sample survey of the food-buying habits of housewives in several European countries.

As part of a plan to improve productivity in retail trading, the Agency has organised successful missions of American specialists who have visited most European countries, holding meetings and giving demonstrations of modern techniques of display, training of sales people, lighting, self-service, stock control, cost accounting, pre-packaging, etc. The Agency is also making more widely known a successful Danish innovation whereby voluntary groups of small retailers have simplified their arrangements with wholesalers and cut their costs to a level which it was thought could only be achieved by the larger retailers.

Trade Union Information and Training

The European Productivity Agency has benefited greatly from the support given to it by the free European trade union movements, from the advice given by the Joint Trade Union Advisory Committee to the O.E.E.C., and by the trade union representatives on the Advisory Board. E.P.A. activities are based on a belief in the fundamental importance of sound labour-management relations, sound democratic trade unions, and trade union participation in productivity efforts as the best way to a higher standard of living. The trade unions have accepted the opportunity offered by the E.P.A., and have given most sincere and effective co-operation.

The greater part of the work of the Agency is of direct trade union interest, but certain E.P.A. activities, developed specifically at the request of the trade union movement, are aimed to improve their information sources and their training in practical industrial matters.

The Trade Union Information Service is built round the bi-monthly "Trade Union Bulletin," which deals with practical industrial matters, the monthly "Newsletter," and the publication of case studies.

The Agency's training schemes are in direct support of union activities in Member countries, and prove particularly valuable where industry is not fully developed or where the trade unions are facing special problems. An intensive programme recently carried out in Greece was very successful. The early example of the T.U.C. in training trade union members in production subjects has been energetically followed in several countries, where more ambitious schemes have been launched.

A recent training project has taken the form of seminars on specific subjects; the first was on the *oil industry*. *Automation*—the subject of the second, held in London on the 14th-17th May with the active co-operation of the T.U.C., was introduced by technical as well as trade union speakers, and attended by a representative of the United Automobile Workers' union of America. This is a typical subject which must be discussed in detail by trade union circles if industrial progress is not to be prejudiced. A further seminar is being arranged on *Works Councils*.

Information is transmitted not only by bulletins and conferences. A scheme for inter-country visits by trade union members to examine technical developments in the industry in which they are concerned, has been particularly successful. Over 200 have now been undertaken, and valuable reports prepared as a result. Examples of United Kingdom teams are: one from the N.U.R. to study the French railway system, one from the A.E.U. to investigate motor-car production in Germany and France, and one from the National Union of Hosiery Workers to France and Italy.

These activities are of great assistance to the overall work of the Agency by facilitating the direct participation of the trade union movement in the joint endeavour to step up the pace of European industrial development.

Agriculture

Some 30 per cent. of the population of the O.E.E.C. countries depend directly on agriculture and fishing for their livelihood and the work of a further 20 per cent. is indirectly concerned with agriculture and food products. At present the cost of food imports into Western Europe is between 25 and 30 per cent. of the value of the agricultural production in the area. Very important savings in manpower and in food imports, therefore, can be made by increases in productivity in this great industry. The E.P.A. reaches the millions of small individual farms indirectly by training key people in each country who in turn help agricultural advisers in their work. Its main aims are: to improve organisation and management of farm holdings; to apply modern techniques; and to improve marketing of agricultural products. Over 1,000 key people were trained last year in 21 courses. The Food and Agricultural Technical Information Service (F.A.T.I.S.) keeps farm advisers in touch with new developments by a bi-monthly review distributed in nearly 10,000 copies in English, French and German, and by many other publications. F.A.T.I.S. also exchanges technical literature between countries, and to this end it maintains liaison centres not only in all O.E.E.C. countries but in the United States, Canada and Australia.

A great effort is being made to control animal diseases. Controllable diseases account for an annual loss of some 1,800 million dollars worth of livestock in

Europe, or nearly 10 per cent. by value of the total agricultural output.

Under a Seed Multiplication project the Agency is endeavouring to multiply cheaply and quickly the best seed available for various crops. Two hundred hectares sown in the best climatic and soil conditions in Greece, Portugal, Italy, Turkey and southern France last autumn and this spring with stock seed from Sweden, Denmark, Germany, Holland and Britain should supply sufficient seed to sow 2,500 hectares in northern Europe. Through this demonstration, the Agency hopes to see such activities carried out eventually on normal commercial lines, and farmers enabled to get improved seed at greatly reduced prices.

Another project of the Agency's Agriculture Division is a survey which it is hoped will lead to a cost-saving re-organisation of European fruit and vegetable markets. Already, as part of the project, a teletype market information service is operating, daily linking six countries. Measures are being taken to set standards for produce and packing. Observations have been made of what actually happens in the European distribution processes and it is already certain that prices can be reduced by the adoption of less wasteful methods. A thorough exchange of views will take place in July, when a conference will determine a possible extension of the service, and assess results obtained so far.

Another project now in progress is a standardised test—the first of its kind—for tractors under ordinary farm conditions. Manufacturers are giving it their fullest co-operation. In this way the E.P.A. is helping farmers to gain knowledge of the various tractors available on the market and best adapted to their particular needs.

Applied Research

Research is expensive and national resources are often inadequate. There is a wide range of research where competitive secrecy is not a restrictive factor and where international co-ordination of efforts can bring quicker and less expensive results.

In one sector E.P.A.'s co-ordinating role may have far-reaching results affecting a basic industry, building, its efficiency and its trade in components and fittings. E.P.A. has undertaken an eleven-country survey of work already done in modular co-ordination, and is promoting the use of a European-wide application of a standard "module" or unit, for building components. Experts from eleven countries have started test buildings based on an agreed module. In the U.K. the British Standards Institution has given E.P.A. invaluable assistance in the promotion of this work.

One problem currently being tackled by the E.P.A. is the fouling of ships' hulls. The first steps have been taken for research to be carried out with an international sharing of costs on this subject which has cost shipowners millions of pounds. It should be noted that the United Kingdom is a leading maritime country and a heavy contractor for shipping space and, in consequence, has probably more to gain from a successful outcome to this E.P.A. project than any other country.

In the earlier days of the O.E.E.C. there was the well-known co-operative venture on the low-shaft blast furnace.

Today another O.E.E.C.-sponsored activity is the international study of the industrial uses of nuclear energy.

The E.P.A.-sponsored research into the desalting of brackish waters has already resulted in a British firm getting the contract to erect a desalting plant overseas.

The function of the Agency is not to undertake research itself, but to provide opportunities for co-ordinating efforts and exchanging experience and ideas. It may be able to withdraw at the conclusion of the preliminary phase of investigation and, at any rate, it should retire from the field soon after the research is under way, or taken over by a body created for that purpose, such as in the case of photogrammetry which is now handled by the European Organisation for Photogrammetric Studies.

The question of automation, now of vital interest to management and trade unions in many industries, has been approached in similar fashion. As a co-ordinated international survey would be of immense value to Europe, the E.P.A. has been instrumental in organising the preparation of a series of national surveys. The D.S.I.R. (as in many other E.P.A. projects) has been responsible for providing the United Kingdom report. These studies, in addition to others dealing with specific cases of industrial application, will form the basic documents for an International Automation Conference to be held in November. Although the problem originally emerged as an aspect of applied research, it will be discussed at the conference from a wider point of view, taking into account the economic and social, management and labour aspects apart from the technological factors.

To apply the findings of research to industry successfully tends to be an even harder task than the actual research itself. To accomplish this more quickly, particularly in small and medium sized firms, the E.P.A. has therefore sponsored the organisation of seminars on applied research. These national seminars have been supported by two international congresses on the same subject.

The E.P.A. has proposed an important sociological study on the reactions of employees in the steel industry to technological changes; and an international conference in Rome provided an opportunity for Management, Trade Unions and sociologists to exchange ideas and compare experiences.

Productivity Measurement

Many recent developments in the technical control of industry, whether in the United States or in Europe have stemmed from the increasing desire and ability of those concerned to think quantitatively. On the one hand there are financial controls provided by cost accounting and budgetary control, on the other hand there is the physical control provided by work study and productivity measurement; their uses are complementary.

In the efficient control of industry the measurement of productivity increase is important primarily for

the factual information it provides. It has also been found, however, that the actual measuring of productivity tends to raise efficiency by providing a direct stimulus to productivity-consciousness.

The E.P.A.'s Productivity Measurement Advisory Service, staffed by experts, is available through national productivity organisations to industrial organisations, and is designed to facilitate the measurement of productivity on a practical basis in industry. It maintains a close liaison with the U.S. Bureau of Labour Statistics. The B.L.S. has conducted 48 detailed studies of performance in particular American industries. These studies provide a valuable basis for comparison with the performance of European factories. The reports are distributed to Member countries by the E.P.A. which also provides advice on the most effective use of the reports. The United Kingdom agent in this work is the B.I.M.

The need for more printed matter on this subject led the E.P.A. to produce its " Productivity Measurement Review " a 4,000 copy quarterly issued in French and English. Other publications include a manual setting out information on systems of productivity measurement in various countries, and a forthcoming pamphlet will take the form of a simplified introduction to the subject for managers and others in industry.

In addition to information and advisory work, the E.P.A. also promotes the advancement of knowledge on productivity measurement by arranging visits between experts in different countries and, in association with the O.E.E.C. by instituting specific studies in selected industries.

Information Services

There is in Europe today a vast pool of technical information which so far has only been partially exploited. It is the role of the E.P.A. to ensure that this information is fully and effectively employed. In some cases the information does not cross national frontiers because of language difficulties, in others, it is not even conveyed from one industry to another.

To tackle this problem the E.P.A. started the publication of monthly European Technical Digests. These are compiled from material received from eleven countries where a total of over 1,000 periodicals are read every month. A monthly selection of about 100 digests is then produced in English and French and is reprinted in the vernacular by Italy, Norway, Austria and Germany. This forms the cornerstone of the Technical Information programme specially designed to help small and medium-sized firms.

The E.P.A. also distributes information and facilitates European exchanges of experience on matters of more general interest to industry and commerce by means of its monthly " Bulletin " and a variety of publications on specific subjects.

In any information work there is a fundamental problem of communications. To this end the E.P.A. has made considerable efforts to stimulate the use of visual aids in education and training. Teams of specialists have organised courses and given demonstrations in Austria, Belgium, France, Germany, Holland, Greece, Italy, Norway, Sweden and the United Kingdom.

A European film library has been set up and now includes nearly one thousand film titles. It is the only one of its kind in Europe and loans some 100 films every month so that countries may screen them before purchasing.

As there are many gaps in national film libraries relating to industrial and technical subjects, the E.P.A. started a European programme of co-producetion of films whereby the Agency pays 49 per cent. of the cost of production and the initiating country 51 per cent. In the United Kingdom a series of seven work study films (four of which have been completed) have thus been produced by the B.P.C. and will be distributed throughout O.E.E.C. countries, some of whom will make their own language versions.

Conclusion

The staff of the E.P.A. are inspired by the fact that industry and agriculture in O.E.E.C. Member countries recognise the value of the assistance they have received from the Agency during the brief three years of its existence. Co-operation is not easy to " sell " as a theory; it has to face the test of practical results. Its benefits cannot be shared out in exactly equal proportions—firm by firm—industry by industry—or country by country. Yet, as in so many activities, benefits have a direct relation to contributions.

The challenge to Europe in the post-war period is such that the O.E.E.C. countries are in their own interests led to participate in joint endeavours toward industrial development.

The Chancellor of the Exchequer, Mr. Harold Macmillan, who is the present Chairman of the O.E.E.C. Council—the first was the late Mr. Ernest Bevin—said in February, 1956:

> " If the 17 nations of Europe had not co-operated, and if the Organisation had not been created and done all this work, I dare not think what would have been the situation of Europe today."

We believe that the examples of the E.P.A.'s activities which have been given in this paper provide sufficient evidence that it is to the advantage of British industry to participate fully in the work of the Agency on grounds of immediate self-interest. There may be some who will still find it difficult to accept the evidence. To them we commend the broader argument stated earlier in this paper—that on both political and economic grounds the true interest of all European countries lies in seeing Western Europe not poor and divided, but united and prosperous, a source of competition perhaps, but also an expanding market close at hand where goodwill is to be found.

INVESTING IN RESEARCH

by PETER SPEAR, B.Eng.,

Director of Research, Rubery, Owen & Co. Ltd., Darlaston, South Staffs.

Mr. Spear

Educated at Humberstone Foundation School; Sheffield University. Served in various production and mechanical engineering capacities with the B.S.A. Group of Companies. Was a Research Engineer in production methods at the B.S.A. Group Research Centre and eventually Senior Research Assistant at the B.S.A. Group Machinability Research Laboratory.

Published jointly or individually eight technical Papers. Has lectured to various Institutions in the U.K., including The Institution of Production Engineers; Institute of Petroleum; Aslib; Society of Instrument Technology; N.T.T.S, etc.

Appointed to present position as Director of Research, Rubery, Owen & Co. Ltd., in April, 1952.

Awarded medal for best Paper of 1949 *and Hutchinson Memorial Award,* 1949, *by Institution of Production Engineers.*

Member of Research and Editorial Committees of The Institution of Production Engineers. Chairman of Sub-Committee on Sources of Information.

"C'est l'ignorance qui sépare les hommes et la science qui les rapproche" —
LOUIS PASTEUR.

INTRODUCTION

This Paper is not an attempt to show how a financial statement of "profit and loss" can be deduced for a research department, nor is it a statistical treatise on manpower distribution. Rather, it is an attempt to show that, with understanding and clear-sighted application, it is possible for Industrial Research to make a significant contribution to increasing the standard of living in the United Kingdom by improving industrial efficiency and the end products of that efficiency.

The application of scientific principles and techniques to industry has been comparatively recent and its significance has been markedly apparent only during the last few decades. Prior to this century the use of the scientifically creative approach in the industrial field was of relatively minor import. This is not derogatory to the work of the brilliant individuals of the last few centuries but a study of that period soon reveals the basic methods to be "trial and error" [1] and "haphazard selection". It can be seen that when a given invention reached a practical form it tended to remain in that form rather than to progress. This is due to the failure to distinguish between the achievement of a marketable economic entity and continual scientific thought promoting further commercial opportunity. An outstanding example is found in the evolution of artillery[2]. Fig 1(a) is an illustration of a feldschlange (field gun) used in the battle of Granson, 1476 ; note the easily moved carriage, towing hook, elevating gear and weight distribution. Such weapons did not change in 300 years, apart from the use of cast iron for shot and as a gun material. Indeed guns used by the Turks at the seige of Constantinople in 1453 were still in use in 1807 and were employed effectively against the British at the Dardanelles.

Practical considerations necessitate that the discussion in this Paper should be limited as given below :-

1. Industrial research has been defined by Hertz in his brilliant doctoral dissertation [3] thus, "the industrial research process represents an amalgamation of scientific creative techniques with economic motivations". That is, the research is defined by having a specific mandate

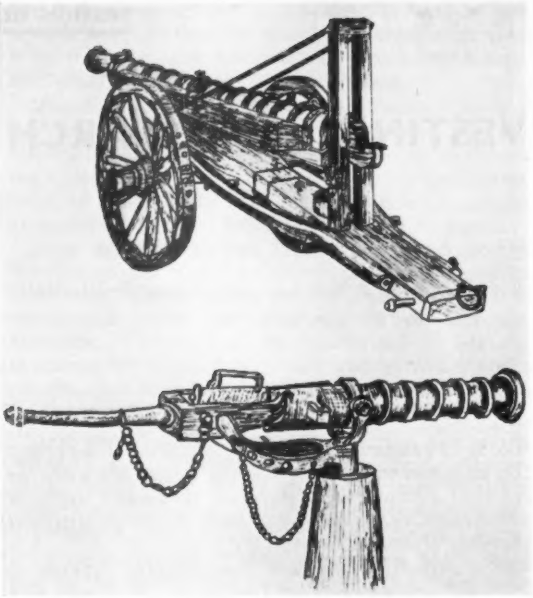


Fig. 1. Guns of the 15th century. (a) *Top Feldschlange*, an early field gun — 1476 ; (b) *Lower Peterara*, an early breech-loader — 1461 - 1463. *(Note the similarity to weapons of the last century.)*

and not an academic project with the object of hope rather than profit.

2. Industrial research includes all phases of the process through to the final development and teething stages of a practical entity, be it a process, a plant, a set of detailed working drawings or a new chemical.
3. The Paper is mainly concerned with work in the engineering field but it is hoped that there are analogies in other spheres of activities.

THE NATIONAL SCENE

General

Many extremely valuable national and international reports (of which references 4 to 11 are but a selection) have been published on the organisation of research and its significance in recent years, describing the overall scene. There are many publications describing the British industrial research activities in particular and perhaps, above all, the reports [12] of the various conferences of Industrial Research Directors and Managers organised and published by the F.B.I. are worth study. The extent of Government industrial research can be ascertained by studying the various publications of Her Majesty's Stationery Office [13–16]. However, in spite of the efforts of D.S.I.R. through T.I.D.U. [17] and C.O.I. [18] including a very useful series of articles in " Target " [19] it would appear that there is some lack of appreciation of the value, both tangible and intangible, of industrial research in management and political circles, using political in the classic sense of " the State or its Government ". Research is not necessarily an expensive luxury to be indulged in during times of plenty ; it is more vital in times of "Credit Squeeze" and competitive markets to ensure that new ideas, improved techniques, better and new products are evolved. The tragic thing is that, so often, it is not appreciated what benefits can be obtained by a correct understanding and use of available resources of men and creative thought.

Expenditure

National

Because of the joint difficulties of definition and security it is almost impossible to arrive at accurate estimates of the total national expenditure on industrial research and development. It was officially estimated in the House of Commons that in 1951 the total expenditure on industrial research and development was £268,000,000, of which probably £70,000,000 was on civilian research. Today that figure may be taken as over £300,000,000, and this would include research activity from the development of standards of linear dimensions at the National Physical Laboratory to mechanical handling methods in Atomic Energy Power Stations, from the development of a new domestic appliance to production techniques in the manipulation of titanium alloys. The national expenditure of the Department of Scientific and Industrial Research is currently running at about £7,000,000, and includes grants to Research Associations [20], Universities, to students and the organisation of the fourteen main D.S.I.R. Research Laboratories [21].

Relative to population, the expenditure is not out of proportion to that of other countries but it might well be conjectured that above a certain level of national population and economy, the ratio of expenditure per head of the population is not too expressive a guide since fundamentally a nation of fifty million or of a hundred million population would require the same research facilities and the volume of production was such that it was a matter of expanding laterally rather than vertically.

It was estimated by the Harvard Business School [22] that during the equivalent period mentioned above industry in the United States spent $2,500,000,000 on research and today this figure is probably approaching, if not exceeding, $3,500,000,000. In Western Germany[5] at the present time, industry alone is spending a sum of the order of DM.600,000,000 per annum in its own research laboratories and the amount of money contributed by the Government to the support of scientific research in academic and independent research organisations and establishments exceeded a similar figure in 1954.

One might well consider these figures against the British estimates of personal expenditure on consumer goods and services in 1954 of £11,854,000,000 and the national expenditure of £4,304,725,810 for the financial year ended March 31st, 1955. In the equivalant period the total expenditure of the United States Government was $67,772,000,000.

Volume I of the O.E.E.C. publication on the Organisation of Applied Research in Europe and the United States and Canada [4] states (page 21), with

TABLE 1

Research expenditure ratios by different nations.

Country	National Civilian Research Expenditure (excluding defence and atomic energy research). Expressed as a percentage of :— (i) Gross National Products.	(ii) National Budget (excluding investments).
U.S.A.	0.5	—
U.K.	0.5	0.8
Italy.	0.08	0.25
Netherlands	0.42	0.52
Sweden	0.21	0.24

Extracted from O.E.E.C. report on the Organisation of Applied Research in Europe, the United States and Canada. [4]

regard to national research budgets, " in the countries visited there was a surprising lack of comparable data on the total investment in research and development. Reliable data do not appear to exist on the basis of either firms, industry or countries." In order to try to give a lead they took the national civilian research budget data provided (i.e. excluding defence and atomic energy research) and expressed them as a percentage of the respective gross national products as published by O.E.E.C. and as a percentage of the total national budget. These pertinent results are given in Table 1. On the figures the United Kingdom appears in a reasonable light compared with some of its industrial rivals but O.E.E.C. state that it should be clearly understood that there is no guarantee that these ratios are exactly comparable nor can data be expected to do more than indicate the then current (April, 1954) expenditure. It is difficult to grasp the significance of any national estimates or to realise what they mean in terms of different types of research from fundamental activities to development of simple appliances or from material development to expense on the dissemination of information. However, as far as the United Kingdom is concerned the presentation given diagrammatically in Fig. 2 is useful. It is taken from a stimulating survey published by the " Economist " [23].

The author would plead that the time has come for an independent body to make a balanced appraisal in this and other countries.

Industrial Expenditure

It is not easy to estimate national expenditure nor is it straightforward to estimate the expenditure of individual industries. However, in this country valuable work has been done by the F.B.I. who have published two surveys [10 & 11] concerned with the financial years 1945 - 1946 and 1950 - 1951. A study of these reports gives at least an indication of the trend in British industrial research. Because of inflationary tendencies it is difficult to compare years. It is interesting to note that for 254 firms considered there was an increase of 52% in the number of qualified staff employed in research and development in the five-year period quoted. Similarly, in 1950-1951 there were 41 research associations [20] (46 in 1956) whose expenditure amounted to approximately £3,400,000 of which £2,150,000 was contributed by industry. In 1945 - 1946 there were only 23 research associations and their expenditure was about £1,000,000 of which £570,000 was received from industry. Research associations will be considered later but their expansion in numbers and size is a very worthwhile contribution to the improvement of national prosperity.

The 1950 - 1951 F.B.I. survey [21] concerned 301 firms whose total expenditure on research and development was £23,779,000. A commonly accepted

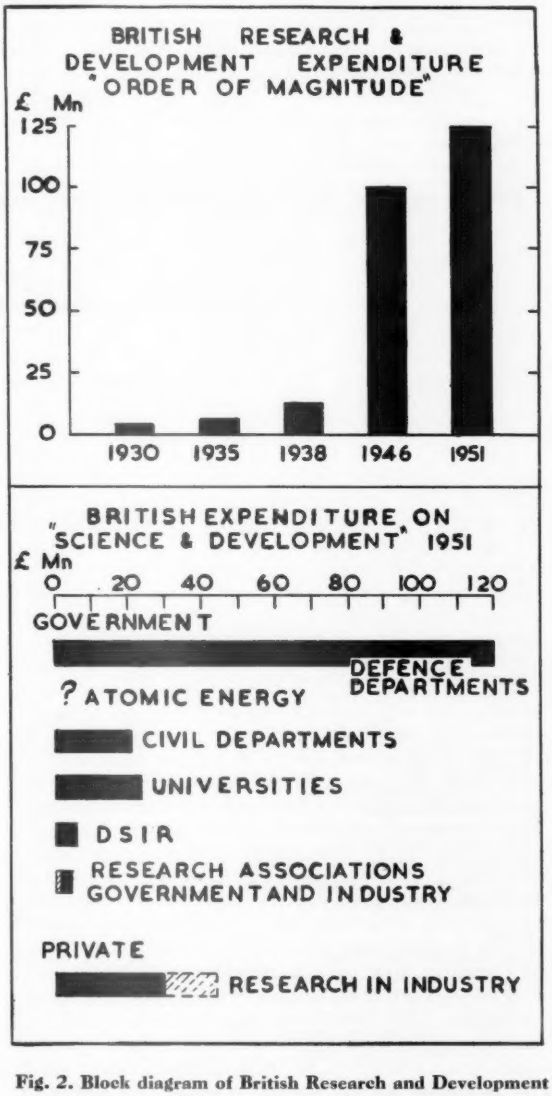


Fig. 2. Block diagram of British Research and Development expenditure in 1951. ***Note — The figures are based partly on guess-work and some specific government data.***

TABLE II

Some expenditure on industrial research in Great Britain, 1951/2.

	Industrial Group	No. of firms in group	R. & D. Expenditure £1,000	Turn-over £1,000.	R. & D. Expenditure as % turn-over	Total R. &.D. staff	Total qualified staff	R. & D. Expenditure per unit of staff	R. & D. Expenditure per unit of qualified staff
								£	£
1.	Chemicals	64	8,903	376,678	2.4	10,705	3,168	830	2,810
2.	Materials								
	(a) Textiles	18	372	72,993	0.5	417	88	892	4,227
	(b) Paints	10	441	38,153	1.2	574	160	768	2,757
	(c) Glass	6	215	17,226	1.2	138	46	1,558	4,674
	(d) Other Materials	22	349	66,076	0.5	375	123	931	2,837
3.	Metals								
	(a) Ferrous	11	513	122,239	0.4	684	205	750	2,502
	(b) Non-Ferrous	13	1,193	109,618	1.1	1,200	346	994	3,447
4.	Food drink & tobacco	13	283	79,223	0.4	356	112	795	2,527
5.	Electrical engineering								
	(a) Heavy	12	2,821	114,654	2.5	4,302	1,364	656	2,068
	(b) Light	13	2,095	39,504	5.3	3,409	540	615	3,880
6.	Mechanical engineering								
	(a) Heavy	31	1,357	197,439	0.7	1,530	475	887	2,857
	(b) Light	49	1,755	153,426	1.1	2,454	629	715	2,790
7.	Scientific Instruments	16	534	10,550	5.1	758	234	704	2,282
	Total	278	20,831	1,397,779	—	26,902	7,490	—	—

Extracted from F.B.I.'s survey[11] of expenditure on industrial research and development in 1950-51

TABLE III.

Some expenditure on industrial research in the United States, 1951/52.

Items	% of 4,800 Respondents Supporting Research	1952 Median Figures for 191 Leading Companies.			
		% Research to Sales	% Increase in spending over 1951	Dollars Spent per Research Worker	% Professional to all Research Workers.
ALL FIRMS.	44	1.3	13	8,400	46
INDUSTRY.					
Food and Kindred Products	31	0.3	8	8,300	46
Textile and Apparel	34	0.7	7	8,200	39
Furniture	27	0.5	9	6,500	19
Paper, Lumber & Wood Products	28	0.7	15	7,100	49
Industrial Chemicals	74	2.9	15	9,400	45
Drugs	59	4.9	12	9,600	46
Paints	72	1.7	8	6,800	52
Miscellaneous Chemicals	69	2.4	9	7,700	39
Petroleum & Coal Products	40	0.7	14	9,000	43
Rubber	53	0.9	21	8,500	66
Stone, Clay and Glass	42	1.3*	14	7,700	37
Primary Metal	43	0.9	11	8,500	40
Fabricated Metal	40	0.7	10	9,600	53
Machinery except Electrical	61	1.4	12	7,300	39
Electrical Machinery	71	2.7	17	8,200	44
Transportation Equipment	51	1.4	9	9,700	36
Laboratory Instruments	87	3.0	40	7,300	37
Mechanical Instruments	69	2.0	11	8,900	52
Other Professional, Scientific and Controlling Instruments	79	2.0	14	10,000	50
SIZE					
Less than 500 Employees	32	3.4	10	8,200	59
500 — 2,000 Employees	80	2.0	16	8,100	49
2,000 — 5,000 Employees	94	1.4	12	8,000	45
5,000 — 7,000 Employees	96	1.2	12	8,200	50
7,000 — 10,000 Employees	97	1.5	13	8,500	46
10,000 Employees or more	99	0.8	14	8,700	41

*** Estimated.**

Extracted from the Harvard Business School's report[12] on Spending for Industrial Research 1951-1952.

form of criterion is to express research expenditure as a percentage of total turnover. Very enlightening figures are given in Table II which is taken from that survey. A similar survey covering the year 1951 - 1952 has been carried out in America [22]. This goes into great detail and Table III is extracted from that report.

In making surveys of this type it is difficult to differentiate between expenditure by the company on its own products and expenditure on products which it may well manufacture for the Government and where part of its research budget is derived from Government sources. Interesting data on this particular problem is given in the United States Department of Labor's study [24] of manpower and costs during 1951 - 1952.

However inaccurate the data, a general pattern rises according to each industry and it is right to expect that some industries will spend far more on a percentage basis than others. Table II, for the seven industrial groups shows that the percentage of turnover spent on research and development ranges from 0.4 to 5.3. A low figure would be expected in those industries such as textiles where the cost of raw materials represents a very large proportion of the cost of the finished product — though even this trade has sponsored the famous "Shirley Institute". In the scientific instrument field, the cost of material is relatively small and almost by definition the industry must spend money on research since the products of research are broadly its direct selling product.

Relationship between Government and Industrial Research

The Government is by far the greatest single body spending money on research in the United Kingdom. In spite of its expenditure on research associations and national laboratories, the bulk of money is directed at defence projects and public services such as power. There is an increasing tendency for research and development work of this nature to be carried out by industrial concerns under Government contract. An interesting account [25] of the evolution of part of the present system has been published recently and a useful critique of the organisation of defence research has been made by Pincher [26]. This applies particularly to the contracts placed by the Ministry of Supply. As stated previously, it is not easy to differentiate between work done under Government contract and work directly applicable to the industry's own needs. For example, when one tries to analyse the research and development expenditure by, say, an electrical company developing radar equipment it is difficult to distinguish :-

(i) development of radar equipment for civilian navigational purposes ;
(ii) development of radar equipment as a "private venture" for possible interest by a Government department ;
(iii) development of radar equipment to a specific specification by a Government department.

The developments that take place in item (i) might well lead to certain staff in the research and development department associated with that project carrying out design work and/or experiments to provide sufficient information to interest a Government department in a particular aspect of that work. Discussions with the appropriate Ministry officials might reveal an interest and the work would progress until eventually between the firm and the Ministry officials a specification would be drawn up which would lead to item (iii), that is, the direct contract. Without going into subtleties, there are various phases between the three major divisions categorised above and it might well be that some of the development work carried out by a Government establishment interested in the same project could in return benefit industry. It is a good trend for research and development projects of national import to be contracted to industry provided they are sympathetically watched by the Government departments concerned. Any development which will be manufactured on a reasonable scale should, at all its stages, be considered in the light of that production, though is often difficult to visualise the final production difficulties that might occur or to realise the final concept of a project at the embryo stages. Nevertheless, it is better that the project should be carried out in some form of industrial atmosphere and industrial incentive rather than by establishments concerned with application only. A dogma must not be established: for example, the Fighting Vehicles Research and Development Establishment in its design and extensive testing work can and does prove a valuable stimulus to industry in the development of heavy cross-country vehicles. At the same time F.V.R.D.E. would acknowledge their debt to the development work carried out by industry and both sides tend to "cross-pollinate" the other.

One aspect of development contracts both in industrial and national interests is the initial production order where, taking the example of a military vehicle, after the initial prototypes have been tested, a small number might be manufactured for service trials in different terrains and operational conditions. This initial production stage is considered as part of the overall development project, i.e. the development of production "know-how" — even though it may be the basis of a different contract. There are many lessons to be learnt at this stage and in spite of all the detailed co-operation that may take place with production departments in the development period, there will still be a number of production difficulties encountered due fundamentally to the difference in technique employed in producing prototypes and producing production quantities. The initial production quantities must be manufactured with the mass production outlook in sight and the design and development team concerned should be prepared to accept readily criticisms of their work and be willing to co-operate in modifying the design if necessary to suit production requirements. Similarly, the production divisions must be prepared to accept some design dictates. As an aside, when concerned with problems of gas turbine blade machining, the author has sometimes felt that if some of the design team had to machine the blades from the solid with their own hands they might not be so anxious to utilise compli-

cated mathematical forms embracing, in one plane, many varying radii with centres forming a complicated pattern in space!

Not all Government contracts necessitate the use of large teams: many are relatively small involving the work of only one or two people. They might be for the development of a particular type of instrument or equipment for special purposes, where it would be better to place a contract with an industrial research department, which has had experience of that type of work, associated with a company that could undertake its manufacture. There are some commercial objections to this; the demand for the final product developed might be so small that it would not be a commercial proposition to market. Nevertheless, such contracts can provide considerable assistance to industry in balancing the load on research and development facilities. For example, a physics section may have certain specialised expensive equipment and a person skilled in its use and application because of isolated problems which occur at infrequent intervals but, which when they do occur, must be solved for the sake of the company's economy. It is not always possible to utilise special purpose equipment or personnel on a full-time basis and the acceptance of occasional contracts balances the load. The problem can be taken further with one industrial research department placing contracts on another and there is undoubtedly a case for the establishment of some Independent Liaison and Co-ordination Centre which could index any spare capacity by research establishments and generally balance the load of the nation. Perhaps this Paper might prompt D.S.I.R. to have a look into the matter.

Human relations between Government departments dealing with this type of work and the industrial concerns undertaking it are sometimes delicate. Industrial research organisations tend to feel hampered by the administrative routines of Government departments who, in their turn, become exasperated with the wide diversities of outlook in firms of a common industry, some of whom may wish to go much deeper into a given problem than necessitated by immediate Government requirements and others over-anxious to consider the commercial implications and productionise with insufficient time for detailed prototype test. In the national interest both sections need to work together more closely and understand each others problems. Recently a research team from the author's department was discussing administrative details with a Government department on a "design parentage". On first sight it appeared that the routine administrative procedures were very complicated. Numerous departments and firms had to have various copies of drawings, the design amendment and modification procedures were complex and so it appeared were drawing requisition procedures. However, an effort was made to make things run smoothly and consequently a small team went into the matter in detail with the designers, administrators and project engineers. One point was very significant. The particular department was dealing with 182 different industrial concerns undertaking design work for them in one form or another — 182 different drawing offices, 182 different financial systems, 182 different internal works standards, 182 different production procedures: yet on detailed examination the Government department procedure works smoothly with all of them and managed reasonably to make a co-ordinated working whole. In those circumstances the "reams of red tape" began to fit into a correct perspective. There are faults, nevertheless. One does see Government specifications for development work to be undertaken which are produced poorly: occasionally there is far too little technical information, not so much in the actual numerical specification of the requirement but in the general technical background which would enable the industrial research man to appreciate the significance of the requirement; alternatively the specification is so detailed that it is almost impossible for the industrial research workers to use any initiative. Industry cannot appreciate always the time scale of Government requirements. The technical men concerned may be extremely anxious for industry to go ahead as soon as possible with any project, yet it may take two or three months for "the official mills to grind out" the paper work, without which industry cannot get any reimbursement. Exasperated Government project engineers may bewail the unwillingness of industry to go ahead and industry in return may point out the fact that much of its work is subjected to a cost investigation.

Tendering for development contracts presents difficulties. The common procedure is that at the time of tendering the department may ask for an estimate to be made of the eventual production costs of the equipment to be developed. Industry's attitude might well be that it has enough difficulty in estimating the development costs of something which is not yet even in an embryonic stage, let alone guess how much it will cost in production. The Government department, on the other hand, might feel rightly that a given firm is stating how economically it can produce the final product which is to be developed and that if they have sufficient expertise to undertake the estimation of the development contract, then they should have sufficient expertise in their other departments to estimate approximately the final production cost.

These problems of administration, human relations and different philosophies need some resolving. At the present time one has only to look at the advertisements in such publications as "The Times" and "Nature" almost begging for skilled technologists, designers, and scientists to enter industry to work on guided missiles, atomic energy projects, aircraft, servomechanisms, etc., to realize how much of the nation's research is being undertaken by industry. It is of the highest importance to the future economy of the country that the different industrial organisations should have a better appreciation of the work and aims of those working direct for the nation and that they in their turn might strive better to assist the needs of those working for them by simplifying and explaining their administrative techniques.

Government Research Establishments

There are 46 Research Associations and Councils [20] sponsored jointly by the Government through D.S.I.R. and the appropriate industries. These range from such long-established bodies as the British Cast Iron Research Association to relative new-comers, like the Heating and Ventilating Research Council. In the engineering field a new-comer which has had a remarkably rapid expansion is the Production Engineering Research Association whose original nucleus was formed by the Research Department of the Institution of Production Engineers. It is perplexing to identify the contribution made by these bodies to the national economy. A simple way is to study a selected list [27] of publications published recently. The rate of expansion of these activities, in line with comments made elsewhere in this Paper, has been rapid over the past decade, but there are useful publications [28–30] surveying the overall scene.

From 1919 to 1953 the number of associations increased from 19 to 41, with an annual revenue increasing from £200,000 to £3,700,000. In addition much intangible support is given to the research associations by industry and the Government, in the form of detailed co-operation in investigations. For example, a member of the author's Research Department was lent to the Production Engineering Research Association for about six months, in 1955, to participate in a survey of de-burring practice in the United Kingdom. The whole programme, which is taking several years, involves not only a study of published literature and practical experimentation in the laboratory, but also detailed surveys of practice of individual manufacturers in the United Kingdom. One of the best ways by which a research association can help the national interest is by co-ordinating the knowledge of individual practitioners into a balanced entity and then ensuring that each individual concern has the benefit of the activities of the industry as a whole.

Considering the small firm, which on so many occasions has been stated to form the backbone of British industry and which can afford but few research facilities of its own, then the research associations, with the exception of Sponsored Research bodies and the educational field, are the only practical potential sources of assistance. This is pointed out by King [31], Kington [32 & 33] and Benton [34]. Kington's work is particularly valuable since, as Research Superintendent of the Cutlery Research Council and the File Research Council, both in Sheffield, he is in the unique position to study research activities in very large numbers of firms whose number of employees is so small that individually they are insignificant, but collectively present a serious contribution to the national economy. Of particular interest to the small firm is the Satellite system described by Kington [32], whereby a group of firms willing to provide collectively a minimum block annual contribution of £3,000 may associate with an orthodox research association to have studies made of their particular problems, provided they are not too remote from the main research association's interest. A corresponding grant would be made by D.S.I.R., but as far as the particular project is concerned it is autonomous and controlled solely by the interested parties. In spite of the criticism that may be levelled at Government departments, as far as the research associations are concerned it is happily true that, though the D.S.I.R. representatives watch the expenditure of Government money and are of great value in performing an intelligent technical function, they do not interfere with administration, either in staff or research methods.

In addition to the research associations and councils the Government, through D.S.I.R., maintain 14 main laboratories [21] specifically concerned with work of a scientific and industrial nature and including the National Physical Laboratory. This year the N.P.L. has extended their industrial and scientific liaison service by appointing two officers whose duties are to interest industry in the results of research and new techniques arising from work at N.P.L. They may be confident that industry would wish them success. This is an addition to the valuable work carried out by the Statistical Advisory Service, under the leadership of Mr. E. D. van Rest. From the industrialists' viewpoint, in addition to the obvious research establishments, there are a number of establishments employing many thousands of scientists and engineers directly on Government work. These would include such well-known establishments as the Royal Aircraft Establishment at Farnborough, the Telecommunication Research Establishment at Malvern, the Fighting Vehicles Research and Development Establishment at Chobham, the Admiralty Signal and Radar Establishment at Portsmouth, and the Admiralty Research Laboratory at Teddington. Additionally there are such bodies as the Atomic Weapons Research Establishments, which have been passed from the Ministry of Supply to the Atomic Energy Authority at Aldermaston. The prime function of these and other establishments is not to assist industry by direct contact, but in practice they do co-operate, not only through the contracts mentioned previously but on any problem of common interest.

APPRAISAL OF INVENTIONS

General

It would appear axiomatic that as the number of sciences and technologies increases, so new developments arise as the work of a team, or even a number of teams, rather than as the "brain child" of an individual. Though there is scope for the highly trained man to make a new stride in his own sphere, progress is fostered and fertilized by colleagues. Certainly most developments are far too complex in their creation and application to be taken *ab initio* to production by the individual — even he who might head the development team. However, there still exists the independent enthusiast and the small company with advanced ideas who believe that they have solved the problem confounding the orthodox structure. The author has little experience of ideas submitted for military purposes, but he has some knowledge of those put to industry. These might vary* from simple "gimmicks" such as a combination

* The examples chosen are genuine — their origin is cloaked in mystery!

tool, to a new process for the extraction of sulphur ; a hot air bed warmer, to a perpetual motion machine; an automatic moulding machine to a gearless variable speed drive ; a clothes washing machine that peels potatoes, to the invention — from six independent sources in a little over three years — of the car bumper so arranged that, when it strikes the pedestrian, it applies the brakes, catches him in a container and generally mangles him in an unconventional manner. The policy to encourage the individual to approach an industrial concern is controversial. The author's experience is that 90% of inventions submitted can be dismissed in correspondence, for various reasons — commercial, technical or physical—without conducting interviews, however tempted one may be to meet the inventor of perpetual motion.

Of the rest one cannot dismiss all without the lurking fear that something valuable to the company and the nation might have been discarded ; certainly in the national interest any new approach to an old problem or new ideas should be examined. One new conception per year might well compensate for the time and money spent in examining a hundred others that were useless : one per cent. would appear to be a good figure according to recent discussions [35]. There are, however, certain standards against which any industrial concern must judge a new idea.

Technique of Appraisal

Rules

The following have been found to be the main questions against which most inventions submitted to industrial concerns can be judged.

1. What is the patent position ?
2. Is it an affront to any known physical principle ?
3. Would it have a reasonable chance of fulfilling its technical function in a form no more complex than justified by the result ?
4. Is there a market and can it be manufactured in a quantity to suit the market, at a price that justifies the "service" given ?
5. Could the company develop and finalise ?
6. Could the company manufacture ?
7. Has the company a suitable selling organisation?

The relative merit of the questions and the order in which they are applied depends on the nature of submission, but they are worth detailed study.

Application of Rules

1. Patent position.

A sound policy is never to discuss an idea or handle any document until the patent position is cleared. Surprisingly few inventors have any real knowledge of patent procedure. The author has been offered "world patents" on the basis of two provisionals. (There is, of course, no such thing as a "world patent" — inventions must be patented separately in each country, except where there are reciprocal agreements.) Similarly, he has been asked to pay £50,000 for three patents, one of which, on examination, was a provisional, one of which had been allowed to expire, and the last bore little relationship to the project. The existence of a provisional gives the appraisor at least some safeguard against being accused of pirating, and it also safeguards the inventor.

Certainly from the commercial viewpoint one would prefer to take over an invention that was covered. The difficulty is that it is very easy to obtain a provisional, not very much more difficult to obtain a patent, but extremely difficult to obtain a valid patent and, according to Blanco-White [37] most United Kingdom patents are probably invalid! It is high time that it was made clearer to potential patentees that the issue of a provisional patent by no means infers that the subject is valid grounds for a patent and the Patent Office might well issue a simplified version of Blanco-White's clear dissertation [36] on the subject.

2. Physical principles.

Inventions are submitted occasionally which are an affront to known principles such as perpetual motion achieved mechanically. Admittedly the realms of nuclear physics today are changing the fundamental concepts of many established principles but for normal industrial purposes the laws of Kelvin and Newton have not yet been repealed.

3. Technical function compared with complexity.

At an early stage a clear concept of the final form of the invention must be reached and considered in the light of the results achieved. Often a fairly simple mathematical analysis can show the commercial absurdity, even though technically a device will operate. An example is the use of gas turbines sucking in fog laden air and sending it several hundred feet up a chimney, thus clearing a town. Simple calculations show that the power required is very much larger than the total amount of power absorbed by the town and its industrial concerns. The experiment is, therefore, not worth making. Similarly there are many household appliances which require a team of skilled mechanics to perform a relatively simple manual task. At this stage of the appraisal a competent designer can soon show that the bumper bar invention referred to previously required a shock absorbing device, probably twice the length of the vehicle, in order to avoid breaking the pedestrian's bones when the vehicle is progressing at even a moderate speed.

4. Selling price.

On analysis many inventions have little or no market to justify development and manufacture and even if there should be a market it will not be satisfied unless the device can be sold at a price which justifies its use.

Recently an investigation was made of a certain device for towing caravans. The patent position was good, it worked and was mathematically sound ; it could be manufactured readily and some potential customers were interested in its purchase. On analysis, however, it was found that the majority of caravans sold either remain on permanent sites or are towed, often by professionals, only two or three times in a

year. Secondly, had the invention a normal commercial selling price it was far more likely that the caravan owner would be inclined to spend the money on a permanent fitting which would increase his living comfort rather than ease the few hours spent in driving.

5. Development potential.

It is a *sine qua non* that few inventions are acquired which do not require either a development team to finalise or even the establishment of a new research team. There are occasional exceptions, but usually these ideas are submitted by external teams rather than individuals. Unless the company has the development potential or the financial resources to pay for external assistance it cannot concern itself.

6. Manufacturing potential.

Again there is usually little point in taking on a device which could not be manufactured by the industrial concern, though if all other considerations were valid then external manufacture might be justified.

7. Manufacturer's selling potential.

This is probably the most severe test and apart from physical considerations one of the main reasons why a company may spurn an invention. There is no point in developing and manufacturing an article or material which cannot be marketed by the existing or a simply expanded sales department. Taking the example of the towing device referred to above, the main reason for its condemnation was that, even though in the final summation, a small market existed, the company concerned, though having a large turnover, had relatively few salesmen since it dealt direct with other manufacturing concerns and had no contact with the retail trade. Caravan manufacturers were not interested in fitting the device, consequently it would have to have been sold through the retail trade. This necessitated a sales organisation for one isolated product, which without a series of associated products would never justify the distribution cost. It is at this stage that the closest possible co-operation is desirable between the sales and research departments.

Disposal of Inventions

What advice then can one give to an inventor who has failed on one or more counts ? If, during the investigation some development work has been undertaken, then it is probably only reasonable to give all the benefits of this to the inventor in return for his willingness to discuss his ideas. Should there be some merit in the device then it may be possible to give him a recommendation to other companies. For example, many ideas for automobiles are not suitable for manufacture as a proprietary article by an accessories company if they are an integral part of the vehicle. However, it might well be possible for the vehicle designer to incorporate the invention and normal industrial relations would demand an introduction to be given.

Sometimes it is possible to suggest that an inventor approach an appropriate research association or Government laboratory who might be interested in assessing the validity of the idea and making recommendations to potential users. Very rarely a device might be of interest for military purposes, but again a suitable recommendation can be made.

National Research and Development Corporation

N.R.D.C. was established by Parliament in 1948 [38] and its terms of reference subsequently extended in 1954 [39]. Its objects, as defined [40] by its Chairman, Sir Percy H. Mills, are three-fold and may be summarised :—

1. It is a single organisation which handles all patents that have arisen because of expenditure of public money and includes patents arising from the armed services, Government ministries, research establishments and the like. It administers these thousands of British and foreign patents on commercial lines and attempts to ensure their full development in the nation's interest.
2. In its conception, it was thought that men of science, especially at universities and similar establishments, were not entirely satisfied with the liaison that existed between centres of learning and research on one hand, and industry on the other, and that the existence of a public body who could assume the responsibility for affecting that liaison on their behalf would meet a real need and enable science to be applied more decisively to industry and agriculture and at an accelerated rate.
3. It was believed in some quarters that the full exploitation of the inventive talent of the nation was in part frustrated by lack of support for inventors, particularly amateur inventors. This covers a range of sources extending beyond that of the amateur inventor without professional qualifications, and includes both professional consultants and any industrial firms which qualify by bringing to N.R.D.C. inventions which they consider to be of public interest.

The prime function of the Corporation is not to exploit the invention itself but to " entrust the exploitation " to existing businesses in the field concerned. Its role is to introduce inventions to industry, if necessary after a measure of initial development at its own risk in its own laboratory or externally, rather than to undertake full-scale utilisation of the invention. It is pertinent to note in the fifth Annual Report that " *our five years' experience has failed to confirm that a multiplicity of meritorious private inventors stand in need of public assistance. Over-optimistic hopes of the possibilities of effecting a spectacular increase in the national wealth by supporting them have accordingly been disappointed.*" Nevertheless, the Corporation fulfills an extremely valuable function since, if industry neglect for individually valid reasons a new invention, this body has the responsibility of giving the final appraisal and if necessary ensuring that suitable exploitation takes place to improve the national wealth.

Purchase of Inventions

Rigid rules for the purchase of inventions by industry are impossible to define. The problem might vary from establishing control of a completely developed device with detailed working drawings ready for immediate manufacture to something which is little more than an idea or a new method of approach. In most cases, however, it is probably true that the amount of work done by the creator is very small compared with the further creative thought and heavy commitment involved in development. Allowing for the cost of tools and plant necessary for manufacture, then the expenditure up to say the provisional patent stage might only represent one or two per cent of the total cost of exploitation. The industrial concern has to invest its money in what, viewed dispassionately, may be a risky venture. The inventor must realise the risk involved. Often he does little more than point out to the company that they had not previously realised that there was a potential for a given device. Having realised the potential, and being in a position to specify it, then normally it should be possible for any competent research department to achieve that specification.

It is preferable to purchase an invention outright rather than to make a nominal payment and arrange for heavy royalties. It presents less of a gamble to the inventor, who may fail to understand why it takes about three years or more before the development comes through all its teething troubles and into production, and from the company's viewpoint a royalty on say, the nett selling price, might be equivalent to half their profit, whereas it is they who have risked all the capital expenditure. The patent position must be clarified too. If the company take on the responsibility of maintaining the patents and all that implies with potential litigation, then the inventor must realise that a heavy burden has been taken from his shoulders and that, in return, he must expect to off-set the company's risk.

The value of the patents as an " invisible export " —so dear to the economist—is worth consideration and instances arise where licence agreements can be negotiated making a worth while contribution to the economy of the company and the country, solely as a result of industrial research.

In complex technical development a valuable policy is to engage the inventor as a member of the development staff on the understanding that eventually he will either carry on with similar development, or assist in the marketing. This can be done with a relatively small royalty, it safeguards the company's interest and ensures that any future idea will be to their benefit, and from the inventor's viewpoint he knows that the development of the invention and his ultimate return depends largely on his own efforts. This is being done successfully with the invention of an automatic moulding machine [41], shown in Fig. 3. This was originally invented by an individual and developed by a very small company with seven employees; the machine evolved as a prototype was suitable for extensive trials. The author's company has employed the inventor initially as part of the Research and Development Department team, with the eventual idea that he will assist in the selling drive, which, since it is a technical product, basically sold by the criteria of technical efficiency and service. The company safeguards the patents and the inventor's interests are also protected.

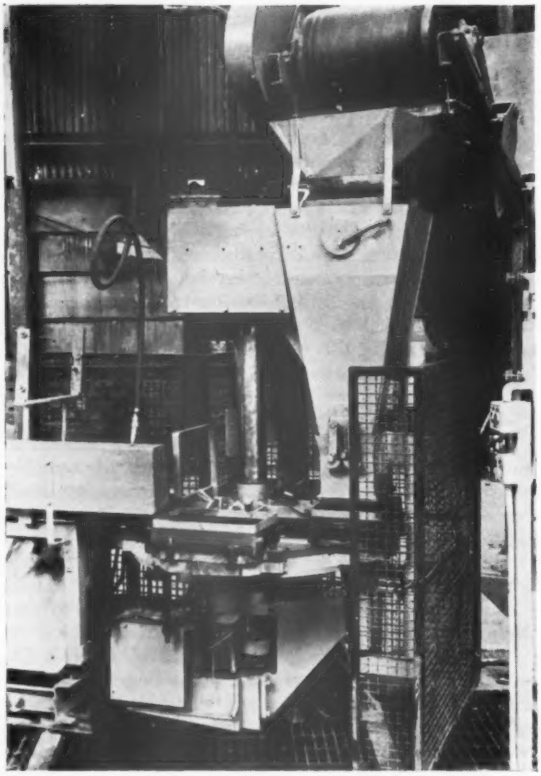


Fig. 3. General view of prototype of Hallsworth Automatic Moulding Machine before final manufacture. *(Courtesy of Rubery, Owen & Co., Ltd., Foundry Equipment Division)*

As originally conceived, the machine was an entity in itself with but embryonic ideas for its application. With the weight of an industrial concern it soon became apparent that it was necessary to merge the machine with a series of different items of plant forming servicing functions and eventually the scheme became a completely integrated system into which sand and molten metal are placed and out of which come castings. The cost of development of prototypes and long term testing was many more times the cost of the initial development work.

SIGNIFICANCE OF RESEARCH PROJECTS

The industrial research department's projects are motivated by many factors—both technical and economic—and the method of approach and the manner in which the work is carried out, varies enormously. It is appropriate in this section to select examples of widely differing problems and to show

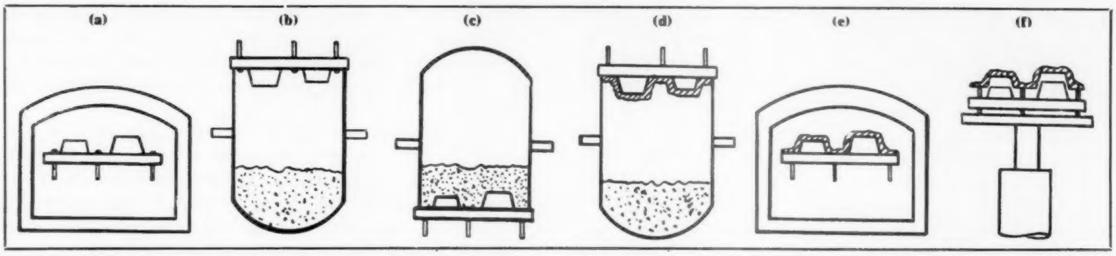


Fig. 4. Schematic diagram of shell-moulding production :- (a) Pre-treated pattern heated in oven ; (b) Pattern placed in " dump box " containing resin and sand mixture ; (c) " Dump box " inverted for a controlled time ; (d) " Dump box " returned to original position and pattern removed ; (e) Shell " cured " in oven ; (f) Shell ejected ready for assembly.

(Courtesy of C. & L. Hill Ltd.)

their significance to production efficiency and improvement of national standards.

The research department may have to develop a completely new product for commercialisation, but most of its work will probably be concerned with improvements to existing products either in their basic form or in their methods of manufacture. Such work can introduce additional problems not conceived in the original mandate. A practical research project in the mining industry, particularly of coal, has been the development of economical hydraulic pit props, replacing conventional baulks of timber. These not only represent a more speedily erected unit but also enable the varying heights and pressures of a moving roof to be met with varying pressure. An interesting humanistic problem lies here; the timber, under load, creaks—that is " talks "—to the miner. Recent studies have been directed at means of producing mechanically the same effect by suitable warning devices.

One research approach is the complete replacement of traditional skills and methods in the light of new knowledge, often from many differing spheres. An instance of this is the development during, and especially after, the War of the " Shell-moulding " process, illustrated schematically in Fig. 4. Traditional moulding technique involves a form of human skill at every phase from the shaping of the pattern to the venting of the mould and final assembly. Shell moulding technique replaces the conventional moulds and pattern boxes by thin biscuits of baked sand and resin, into which metal can be poured direct. Modern metal cutting equipment produces an accurate pattern mounted on a precision steel plate with various locating positions; this, after initial pre-treatment with suitable silicone products, is heated and then placed in contact with a mixture of special sand and suitable artificial resins. After a matter of seconds the plate, with its thin shell of dough-like material adhering, is again heated to bake and cure the mixture. The resultant shell is ejected from the pattern using what are essentially press tool techniques. The entire process might take one minute and when the halves are joined together by adhesive or mechanical means and poured, the resulting casting not only has an improved finish above traditional methods, but is also considerably more accurate. Thus an entirely new manufacturing method has benefited from research in such diverse fields as metal cutting, plastic technology and casting procedure.

An entirely different approach to the same problem, i.e. that of obtaining better and cheaper castings, has been the development of the Hallsworth Automatic

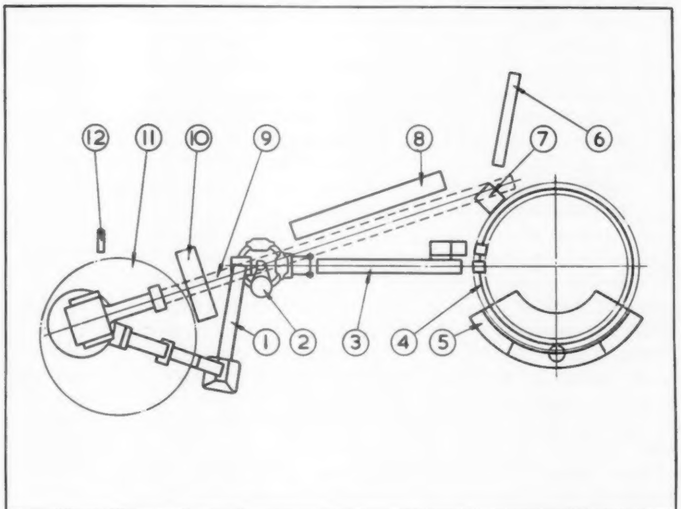


Fig. 5. Schematic layout of Hallsworth Automatic Moulding System.

Key to Layout :-
(1) Sand belt conveyor ; (2) Automatic moulding machine ; (3) Coring conveyor ; (4) Rotary mould conveyor ; (5) Pouring mechanism ; (6) Shake out ; (7) Casting delivery conveyor ; (8) Mould box return conveyor ; (9) Underground sand return conveyor belt ; (10) Magnetic separator ; (11) Sand reconditioning plant ; (12) Control panel.

(Courtesy of Rubery, Owen & Co., Ltd., Foundry Equipment Division)

Moulding System 41 referred to previously. A general layout of the system is shown in Fig. 5. This is the development of an almost completely automatic moulding system using conventional sand but whereby all the operations involving skill and/or high operator fatigue have been eliminated. It is possible for a team of five operators to turn out castings from, say, 240 moulds per hour, the moulding box size being 12″ x 9″ x 5″. It might be argued that such development is basically that of a production department but this type of project involves testing of individual parts of the complete entity, technical sessions with various outside suppliers, detail design work not only of mechanisms but also from the stress and utilisation viewpoints, prototype testing and the like. That is, it involves various facets of different types of human knowledge and experience with creative thought, which is the main criterion of a research department's approach. Interesting human problems arise with the development of such a method since traditional skill is replaced by a speedy, manipulative skill. So far it has been found that, because of the difficulties of teaching new skills to experienced operators, it is preferable to set up a new department staffed by operatives who are, in the main, unskilled in any foundry art.

Having achieved a given industrial advancement it is often difficult to identify the original motivation, but much progress has been initiated by purely commercial considerations. A recent example is the continuous pressed steel axle case where the hub ends are formed as an integral part of the body. The commercial stimulus was two-fold. The vehicle manufacturer obviously wishes to buy his cases cheaply and at the same time the lorry user wishes his axle, and for that matter his complete vehicle, to be as light as possible relative to pay-load to increase his operational efficiency. One recent example of British technique in this field is the evolution of a high-tensile case, a very simplified production sequence of which is shown diagrammatically in Fig. 6. Essentially, two simple pressings formed from a fabrication of thick and thin plates produce the basic case after an automatic submerged arc seam welding operation. The thicker material at the hub ends allows precision machining operations to take place to receive the bearings, without jeopardising the strength of the case at the highly stressed region between the bearings and the spring seats. Not only does this technique involve production research ; recent advances have resulted in the use of arms of rectangular cross section designed mathematically to withstand all the shocks and stresses of vehicle use. Such a mathematical approach is not complete without fundamental investigations in the laboratory to verify these stresses, as shown in Fig. 7 and to prove that this type of case will stand up under operational conditions. Further research is necessary including ensuring the design is no noisier in operation than conventional designs. A recent study has proved the possibilities of not only halving conventional weight, but almost halving the cost.

This type of development is not necessarily the work of the research department. It involves the consultation of many people from welding technicians and plant designers to the production personnel. Additionally, the commercial side must be satisfied that a market exists which such a development can satisfy.

This leads to an important concept in the final work of the research department, i.e. prototype or pilot plant testing. The final proof of the success of a new development is in its practical utilisation, but before this stage can be reached it is necessary to be able to differentiate between different designs, and to sort out a minimum number of types for final service trials. Consequently tests of complete entities are desirable and equipment may have to be devised that bears no relationship to the common concept of the

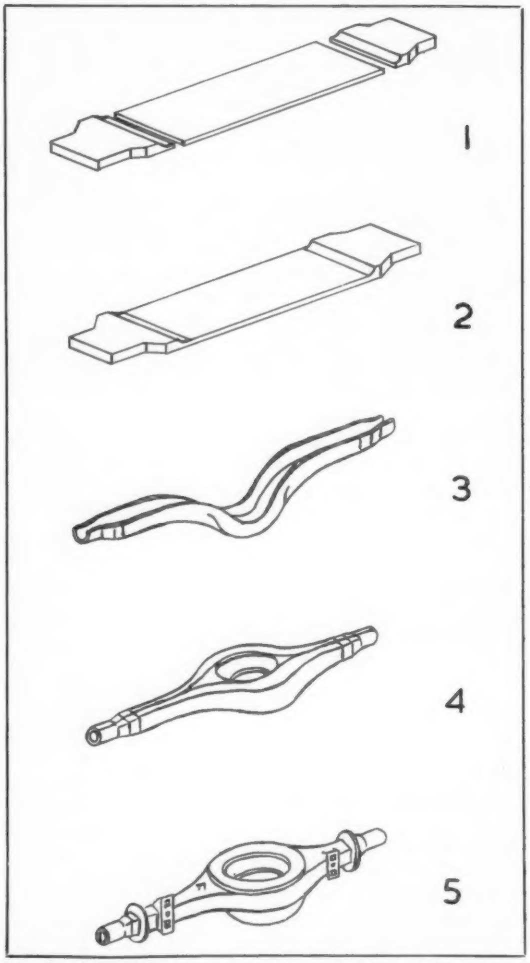


Fig. 6. Simplified sequence of production of heavy rear axle case in pressed steel. (1) Exploded view of steel strip and pressed steel components ; (2) Flash butt welded fabrication ; (3) Half pressing produced and edges prepared ; (4) Automatic seam welding of half pressings and gussets fitted ; (5) Case machined and remaining components assembled.

(Courtesy of Rubery, Owen & Co., Ltd.)

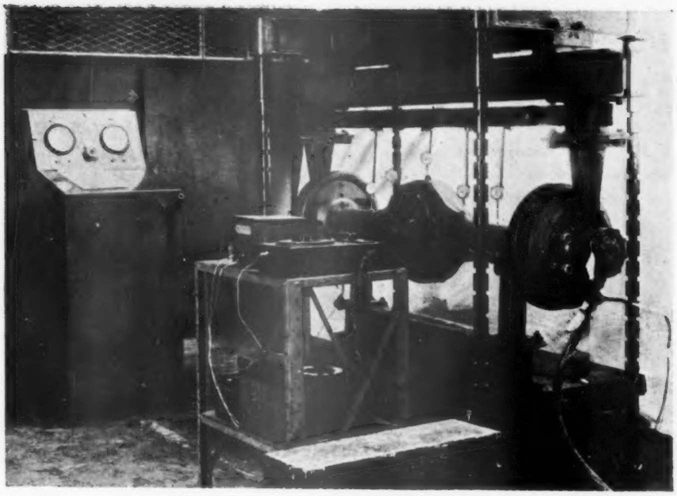


Fig. 7. 30 Ton compression testing machine for stress and deflection tests on axle cases. ***Note — Strain gauges have been fitted to the half shaft.***

(Courtesy of Rubery, Owen & Co., Ltd.)

testing laboratory. The equipment shown in Fig. 8 was devised to carry out tests on complete commercial vehicles and is capable of taking, for example, a fully laden omnibus run out over the equivalent of a rutted road, measuring its overall power efficiency, braking efficiency, transmission efficiency, and enabling observers to study deflection characteristics, make stress, noise, frequency measurements, etc., to assist in the final development. Similarly, in some instances it is only necessary to investigate an axle, and it is possible to mount the axle in a slave chassis with its normal springs and shackles and drive the case from a static motor via a torque measuring prop shaft. As far as the axle is concerned it is running under torque conditions over difficult terrain so loaded up through the dynamometer that it could be going up a 1 in 4 incline.

On the same principle, but for an entirely different industry, the equipment shown in Fig. 9 was evolved to carry out destruction tests on executive type chairs. The chair is subjected to simulated operational conditions. It has a load on the seat and the chair swivels relative to the base. During each swivelling motion a weight is transferred to the arm, equivalent to the executive leaning his elbow whilst answering the telephone. In spite of the numerous strides made in recent years in the ergonomic field of designing chairs to suit particular operations, there would appear to be few examples of ensuring that a scientifically designed chair is also a sound engineering product.

The developments discussed so far concern particular industries, but commercial concerns also have an interest in the wider concepts of national economy, as is evidenced by the co-operation of industry with such a body as the British Standards Institution. In the evolution of a standard it is not only necessary to ensure that the specification will satisfy both manufacturer and user, but also that the products made to that specification must be technically correct. An example of this is shown in Fig. 10, which illustrates deflection tests being carried out by an industrial concern in order to obtain data which eventually provided the safe-loading tables of the British Standard on steel shelving [42]. The experimental corner posts and shelves were made by several different firms and the testing contributed by another. As manufacturers it is in their interest to assist in the formulation of such a standard, but to give them credit, in a product of this nature, the size order of materials does not have any marked influence on the methods of production.

The application of electrical techniques and the developments taking place in the electronic field are opening new vistas on the industrial scene. The establishment of even a modest electronic section involves a fair expenditure on the part of the research department, but the services of such a section can be applied in widely differing fields, from the application of devices to assist the production department to the evolution of new products. The currently conceived form of electronic research is, of course, in the field of automation to which the Institution of Production Engineers has made such a marked contribution [43]. An example is given in Fig. 11 illustrating the application of computer control to a production milling machine producing very precise components in the aircraft industry. The mechanical testing of the component is completed and the drawings peculiar to this type of control system are drafted and the plant information consisting of component shape, material, etc., is fed into the computer which calculates cutting times and movements on the various faces of the component. From this data pulse trains are generated for the control and positioning of the machine table. In the computer all the control information is recorded automatically on to a magnetic tape which at a later stage will drive one or more milling machines. The magnetic tape is passed through the control unit at the machine and the information concerning table settings, depth of cut, etc., is taken and applied to the drive mechanism of the machine table. An example has been quoted [44]

Fig. 8. Automotive test plant for obtaining performance data on complete commercial vehicles under simulated operational conditions.

(*Courtesy of Rubery, Owen & Co., Ltd.*)

Fig. 9. Swivel chair life test rig.
(*Courtesy of Leabank Office Equipment Limited.*)

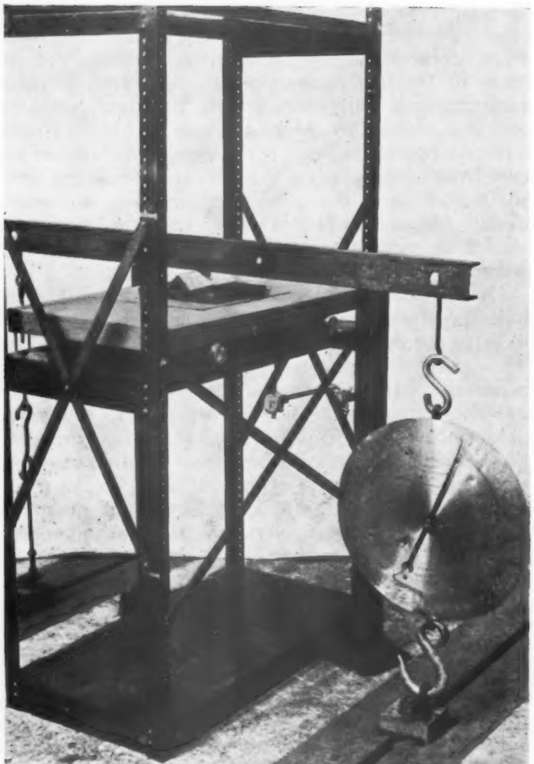


Fig. 10. Deflection tests on B.S.I. standard shelving.
(*Courtesy of Rubery, Owen & Co., Ltd.*)

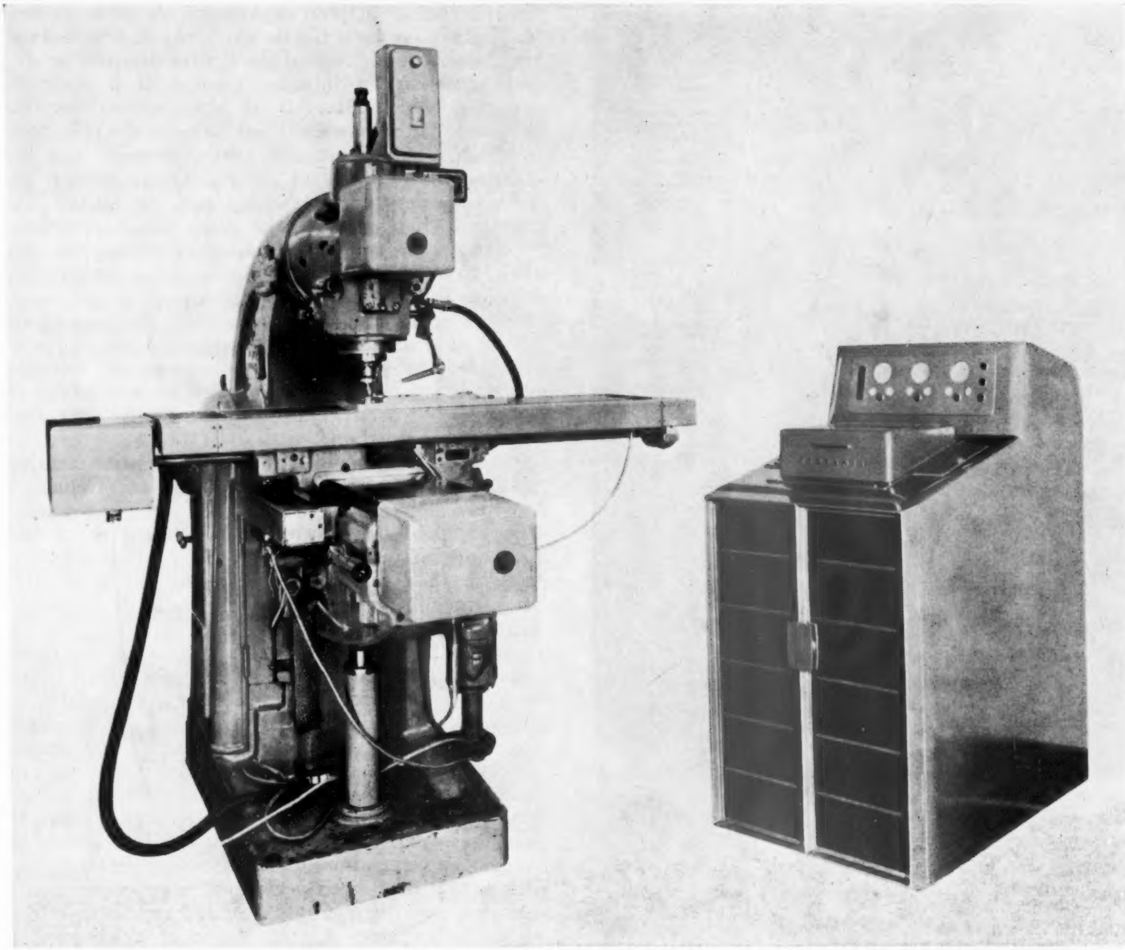


Fig. 11. Computer control of production vertical milling machine. *(Courtesy of Ferranti Limited.)*

where the setting up and production time for one component by conventional methods is twelve hours, but electronically controlled is only two hours — that is, half-an-hour for machining and one-and-a-half hours for establishing the instrumentation.

Primarily, however, in a research department unassociated with the electrical industry the basic function of the electronic section is as a service to the research department and its contacts. A very recent example of the service function assisting the production line is shown in Fig. 12, which is a device for checking the accuracy of wheels completely automatically. The illustration shown is the prototype developed by the research department, which obviously needs routine modification to adapt it to the flow-line of production, but nevertheless, such a device is capable not only of checking but also of warning when faults occur, and showing arithmetically the most prevalent type of fault. It should be noted here that the national tolerances on wheels are such that, in order to take full advantage of them it is necessary to inspect for wobble and lift independently of the basic dimensions so that measuring units must indicate the error, which could be inherently different for identical wheels flowing off the production line. The device was tested, stripped of all guards, under extremely dirty conditions over the equivalent of inspecting several million wheels before it was decided that it had sufficient strength to withstand the hazards of operational use. A calibration device was evolved which would set a given head in a matter of minutes to make the work of the human operative as fool-proof as possible.

To go from the sublime to the seemingly ridiculous, Fig. 13 shows an electrical device which automatically operates a flushing cistern every 20 seconds, recording both the number of pulls and the number of flushes so that, by taking two readings at suitable intervals it is possible to ascertain when the cistern syphonic mechanism is revealing signs of wear. By the use of

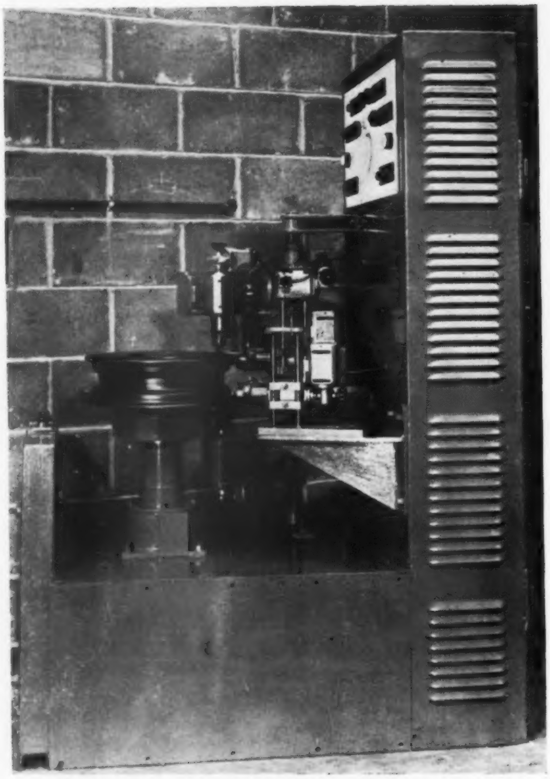


Fig. 12. Automatic inspection rig for determining " lift " and " run-out " of car wheels.
(Courtesy of Rubery, Owen & Co., Ltd.)

such devices it is possible to develop mechanisms for the home which are cheaper and more efficient, and in this instance surely help to improve the national well-being!

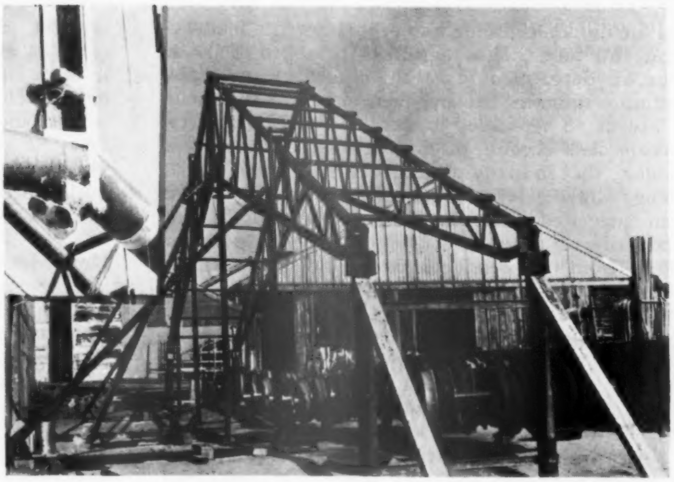
Research departments' activities are not necessarily confined to small-scale projects. Fig. 14 shows tests taking place on a 60 ft. roof truss in order to ensure that it will stand up to operational conditions and verify the stress calculations of the design team. In this particular instance the design work was carried out by the research department in connection with the manufacturing concern, but from the design viewpoint the research department was fulfilling a service function on an appliance which might well have been designed by the production department. Special bolts were placed in the apex joints, fitted with strain gauges to measure the loads. Similarly strain gauges were fitted on the rafters and other highly stressed members and this represents what is believed to be a new departure in steel truss design employing a simple technique used by skilled technicians.

Research is also directed to the individual tools of the production lines. Obvious spheres of activity are the small tool and cutting fluid industries and both industrially and nationally sponsored research departments are actively exploring these fields. Recent highlights have been the development of new surface treatments for high-speed steel, whereby part of the tool serves as an intimate portion of a layer of material, which, though of only sub-microscopic thickness, can reduce frictional forces at the chip/tool interface, thereby reducing heat generation and increasing the replacement period. Great interest lies in the better understanding and application of chemical changes that take place when a cutting fluid passes through the holocaustic conditions between the chip and the tool. Traditionally one cooled with water or lubricated with oil. Today one is concerned with molecular manipulation, utilising the compounds of the fluid and the solid materials of the tool and workpiece to produce minute smears of metallic soaps and similar compounds which act as a lubricant and are destroyed almost simultaneously after fulfilling their function.

Such work can involve not only a scientific creative approach to the traditional problems of production but may also embrace associated academic research. Fig. 15, published recently[45], is believed to be the first time that a relationship was evolved between stress on the surface of a component and its texture. It is difficult to forecast where such development might lead, but it should be borne in mind that the finish and the stressing of the surface of the component bears a direct, though complex, relationship with its fatigue life and its function. Associated witn this work were drilling tests[46], published independently, which are a statistical treatment of the simple procedure of testing drills which resulted in mathematically valid comparisons of different surface treatments and high-speed steels. Similar work 47 has been carried out to compare the effect of manganese segregations on metal cutting performance. The actual operations performed were conventional and it is only the scientific care and treatment of the numerous variables that enables valid conclusions to be drawn, instead of relying on the opinion of shop personnel whose judgment is influenced by numerous extraneous causes not concerned with the work in hand.

Fig. 13. Automatic rig for life testing flushing cisterns.
(Courtesy of Easiclene Porcelain Enamel (1938) Ltd.)

Fig. 14. Full-scale stress and deflection tests on 60 ft. span tubular steel roof truss. The truss on the right is under test, that on the left is a "slave". The insert shows special bolts fitted with collars, having strain gauges in position to measure loads at the apex joint face.
(*Courtesy of Salopian Engineers Limited*)



One has only to look at the preprints of the Papers presented at the Institute of Metals' Symposium [48] and perhaps in particular the Paper by Galloway [49] to appreciate the benefit of an independent creative approach based on an intimate knowledge of practical factors. A similar approach has been made on the particular problem of machining gas turbine alloys [50] when an attempt was made to put the results of numerous research investigations into a practical form, readily understood by production personnel.

APPRAISAL OF INDUSTRIAL RESEARCH PROJECTS

General

Space does not permit a detailed survey of many of the facets of the problems associated with the organisation and control of industrial research projects, either from the industrial or national viewpoint. There are many topics that might be discussed,

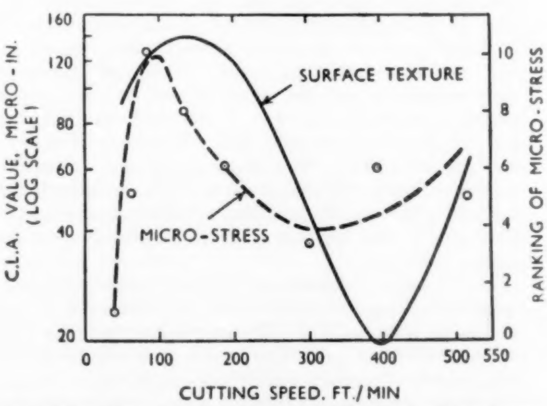


Fig. 15. Relationship between ranking of micro-stress (arbitratory scale) and C.L.A. values against cutting speed for mild steel.
(*Spear, Robinson, Wolfe*)

including the organisation of research departments from the use of one part-time graduate in a small concern, merely priming the principal with technical information, to the giants of industry where the research department associated with a single division might employ over 300 people. The interplay of the relationships between research departments, production departments, sales departments, the board and other interested bodies is of great interest; methods of budgetary control are important, but the author can do little more than refer to some of the stimulating works [51 - 58] that have been published on these and similar subjects. However, it is pertinent to the present theme to consider some of the factors influencing the decision to accept a given project.

Who Originates?

Furnas [56], in his treatise on the organisation and management of research in American industry, suggests that the percentage participation of various departments in selecting research projects is:-

	%
Research Department	48.5
Operating Department	18.2
Sales Department	16.4
Executive Department	13.5
Legal Department	1.2
Accounting Department	0.17
Traffic Department	0.12

Rockwell [51] suggests a slightly different breakdown:-

	%
Research Department	44
Operating Department	15
Sales Department	15
Executive Department	11
Others	15

As far as the British scene is concerned there would appear to be no common denominator, due possibly to the wide range of the size of research departments

and the difference in their co-ordination into management structure. It is agreed [12] that provided the research department has an intelligent mandate, including sufficient money, then either with its own or associated resources it can provide the answer. Perhaps it is because of the need for an *intelligent* mandate that so many projects originate from "initial selling" by the research department itself. It has been suggested that the sales department is not necessarily as fertile a source of projects as might appear from first considerations. It depends largely on the nature of the product. Where there is considerable detail which could only be readily assimilated by studying the field then the sales department can be valuable. Where there is a straightforward technical line of communication between research and the consumer, via pilot plant and technical liaison work, then there is a direct "feed-back" which almost by-passes purely commercial considerations. However, on top management level the basic problem of any research director, no matter with whom he is co-operating, is to discuss projects which will not be a commercial or production proposition for, possibly, several years to come. The sales side tend to be interested in solving immediate problems leading to immediate business ; production personnel are always interested in help to solve outstanding bottle-necks, but neither tend to take kindly to spending this week's time discussing a nebulous proposition which, at the best, only has an even chance of becoming a practical realisation in four years' time! It is in such instances that the research director's tact in arranging for the proposition to be put to him as another party's idea is a great asset. The Manchester enquiry [8] recorded a lack of understanding between top management of some companies and scientists — "they might be living on different planets". This attitude does not help the research project if it is to have an easy birth and thrive in the correct environment.

How to Decide ?

Every project of standing has to be judged on its own merits and Lord Baillieu, at the Third Conference of Industrial Research Directors [12], has suggested the following as criteria which make a new idea a commercial success :-

1. Will it cheapen a product which is in demand ?
2. Will it substitute a cheaper product for one which is in demand ?
3. Will it improve quality in relation to cost ?
4. Will it supply a need at present unfulfilled, and, especially, will it attract the customer by enabling him, in turn, to save time, money, or effort ?
5. Will it reduce dependence on imported materials ?

Against these hard tests a research programme should be judged, and it is likely that one would find a number of projects that will be cancelled.

There are, occasionally, projects which cannot be judged in terms of potential profit or saving. There is the urgent problem that has to be settled independent of immediate cost since without its solution, loss of business may occur — an interesting example of a furnace failure that had to be settled in eight hours is quoted by Chesters [59]. The problem of balancing projects is one of the prime considerations of the research director to ensure that long-term investigations carry on in spite of immediate needs, yet that an immediate problem on the shop floor is not evaded for an idea that might show a return in the years to come.

How Much to Spend ?

There are extremist views on the amount of money to budget for research. Overall patterns have been discussed previously but the attitudes of individual companies may show wide divergences. Rockwell [51] in his invigorating Paper on the executive's responsibility to stimulate research suggests the research director should be given "a stack of chips" and allowed to go ahead with an occasional check to ensure that he is on the right lines. Elsewhere [53 & 60] complete budgeting schemes have been proposed whereby the initial cost must be estimated and the actual cost carefully vetted at each stage. The Board of Directors obviously need some guide on the total cost of research, and in the author's view this should be treated as a percentage of total investment rather than of turnover, though in order to present an overall picture it has been necessary to refer to turnover in the earlier part of this Paper. Investment in a company involves thinking in terms of the future. So does research. Turnover shows the validity of the investment procedure. As such it is a useful method of reviewing research, but not planning it.

How much to spend depends on the nature of the product, but a useful rule in the engineering field is that the total cost involved in research and development including final prototype, working drawings and instructions for a given new product, should be equivalent to the gross profit made in the first three or four years trading from when the product is first to be on the market. Such a rule must vary with the nature of the business, but on the basis of, say, 7 to 10 years trading without *fundamental* change in design, it is a useful criterion. The period of three to four years includes the commercial aspects of stimulating the market, and in the overall period quoted it might only be at the end of the second year that selling was in worthwhile quantities. The rule does not imply that the company does not make any profit for four years ; indeed, it would be hoped that the selling price of the product would bear the cost of development during that period in addition to the profit.

The amount of money to be spent depends not only on potential profit, but also on the likelihood of the success of the project. If the chances are that the project will be a success — and it is the professional duty of the research director to estimate this, just as it is the professional duty of, say, the sales director to assist him in formulating the final budgetary proposal — then it obviously justifies a much greater expenditure than a project where, though the potential return is excellent, the chances of success

are singularly remote within a known time. Again, the total expenditure of the department and its associated staffing must not get out of bounds relative to the company's activities as a whole. The compromise then, would be for the Board of Directors to estimate an approximate annual expenditure on research and within that overall figure to agree an amount for short-term and routine work, and to ensure that each major project is estimated separately before committing heavy expenditure, yet within the framework of the whole to allow the research director to do investigations on his own responsibility from which to formulate his suggestions for long-term work. The research department should not drop an eminently suitable project for want of funds for the simple reason that it comes near the end of the financial year, nor should it be diffident at the beginning of the year. Rather there should be continuity of project balanced against profit.

UTILISATION OF INFORMATION

In 1924, Lord Swinton, then President of the Board of Trade, sent the following message to the first Aslib Conference :-

> "The growth of knowledge during the living memory has been remarkable and its application evident in every direction. Whilst it is generally recognised that 'knowledge is power', it is none the less true that a considerable proportion of accumulated knowledge, whether in the domain of science, business, sociology, education or elsewhere, is unfortunately lying dormant and untapped."

How much more true is this today? It has been estimated 61 conservatively that nearly two million technological publications are added to the world's libraries annually. To this fantastic fund of knowledge must be added the even more significant practical "know how," which defying description can be obtained only by discussion between mutually interested parties. The exploitation of both types of information is an important, and not always fully appreciated, field of practical utilisation of research which involves the use of trained specialist personnel. Under our present educational system few industrial personnel in any shpere, let alone research, are trained[62] to utilise fully the sources of information available. For example, how many commercial people are familiar with "Thomas' Register"[63]? How many technicians are familiar with the "World List"[64]? Indeed, how many normal industrial personnel could obtain every one of the references used in this Paper ?

The problem is not only one of location, but of specifying the actual problem. A classical example is the gentleman who asks the librarian for information on lubricating oils, when he really requires information on the type of oil to act as an upper cylinder lubricant in a particular type of steam engine. Training in this sphere is almost non-existent, though various bodies have done pioneer work and reference should be made to the work of Sheffield Public Library in training school children in the use of public library services. Great benefit lies in training specialists who can interpret a given problem and direct it to the appropriate agent, whether human or bibliographical, and subsequently provide the relevant data in a collated form. Typical sources of information are :-

(i) the public library system, with its extensions into regional and national schemes ;
(ii) universities ;
(iii) scientific and commercial societies and institutions ;
(iv) Government departments ;
(v) Department of Scientific and Industrial Research and research associations ;
(vi) industrially sponsored research organisations.

The amount of information available to *bona fide* enquirers, at virtually no cost, is almost fantastic, and savings in research expenditure, not only of importance to the small firm, but also to the large, can be made by the appropriate use of information which has been published or which can be obtained by direct contact with the appropriate expert. The difficulty lies in location. The public library service has done pioneer work in this field[65] and it is interesting to note that the Library Association is exhibiting at the "Production Exhibition" for 1956. To quote their Secretary they are "trying to bring out the fact that information exists, that an organisation to exploit it is there and that organisation stands at the ready". Aslib — the Association of Special Libraries and Information Bureaux—is also exhibiting to demonstrate how the application of skilled practitioners and specialised techniques can capitalise a useful result for the multitudinous and diverse sources of information existing today.

As well as public library services those of D.S.I.R. are free, and, for that matter, most research associations are willing to assist an industrial enquirer, even though the likelihood of that enquiry leading to potential membership is extremely remote.

Industrial research departments recognise the need for information work and that trained personnel are necessary to exploit it. In the author's research department, where an industrial group Library and Information Service is organised, the situation has arisen that, though managerial level inquiries are of obvious significance, many economies can be achieved by granting access to suitable information to the lower levels of production personnel. As an experiment a system is being tried whereby a particular production department has an engineer whose duties include that of "Library Representative". The shop personnel may take their problems to that person, who would, if necesary, deal with them direct, or formulate the problem relative to the department's needs for submission to the central authority. This has brought to light certain gaps existing in shop knowledge and it is felt that the next few years will prove such a system worthy of extension.

THE RESEARCH WORK OF THE INSTITUTION OF PRODUCTION ENGINEERS

Through its numerous activities, and especially the organisation of such conferences as the recent one on automation at Margate 42, the Institution of Production Engineers has shown itself interested in

research activities. It has a Research Committee which has been in existence for many years, including in its membership representatives from the universities, institutional and industrial research fields, as well as Government departments, technical colleges and the manufacturing sides of industry. It has published a number of reports [66] and at present has the following active sub-committees :-

(i) Materials Handling Sub-Committee ;
(ii) Material Utilisation Sub-Committee ;
(iii) Joint Committee on Measurement Productivity ;
(iv) Sources of Information Sub-Committee ;
(v) Sub-Committee on Quality Control.

Most of its work is done by voluntary effort, but it is anticipated that a permanent technical staff will be available to carry out the work sponsored by the main committee.

The Committee represents a wide diversity of experience in the production enginering field and there in one important aspect of such a pool of knowledge that should not be overlooked. There are various bodies undertaking research, or with the facilities to undertake research in fields allied but not necesarily immediately connected with production engineering, but the results of whose work may well have a practical application : e.g. academic work in industrial psychology, training of operators, metal forming and so on. Though it may not be possible for the Research Committee to undertake the active control of such work, there are instances where it could give valuable advice in assisting the research workers by directing their activities to lines of practical value, and, indeed, formulating the mandates of doctoral theses. Contacts between industry and the academic field can be fostered by this approach. Some work has been done but there is much more to do. One very obvious method of giving assistance has been where the research committee has given investigators high level introductions to companies who would afford them full access to their works and personnel for field research purposes.

RESEARCH TECHNIQUES APPLIED IN OTHER SPHERES

Over recent years the development of the "scientific approach" has lead to the application of research techniques in fields normally unassociated with industrial research. These less tangible forms of research are yielding great benefits to the nation : the techniques of operational research advocated by Sir Charles Goodeve[66] & [67] can lead to economies in such subjects as the flow of materials, planning production sequences and quality control. The British Iron and Steel Research Association have gone to the extent of setting up a complete operational research advisory service which is doing fine work in the steel industry. Today, many of the larger firms have their own operational research teams and the Institute of Engineering Production at Birmingham University is now running a series of courses[68] for senior executives on this subject.

Market research techniques in the strict sense can be regarded as an interesting adaptation of scientific thought to the analysis of commercial problems, whereby statistically valid methods are used to provide data, not only to formulate sales policy, but also to assist in the formulation of research policy. There is a two-way flow of scientific method, however, and the increasing use of the film not merely as a documentary aid, but as a research technique[69] is worth noting.

CONCLUSIONS

It has been necessary to omit many topics and to touch others in but a cursory fashion. Mention might have been made of the value of co-operation between industrial research and educational bodies[71] & [72] : the study of human fatigue and human reaction to differing circumstances are as significant to the national standards of living as technological advances. No mention has been made of the importance of sponsored research such as the Fulmer and the Sondes Place research institutes. The author is conscious of the limitations of the Paper but is also pleased that it has stimulated him to study much that is worthwhile.

Perhaps the greatest single research objective that will contribute most to the national well-being is as yet only beginning to be understood. This is the problem of Communications in all its applications, which perhaps is the only means which will solve the problem so vividly expressed by Drucker[73] where he states :—

> "As the technology unfolds it creates more and more diversive products with different markets, different objectives for innovation — and ultimately even with different technologies. The point is finally reached where top management cannot know or understand what the diversive businesses require—or even what they are. The point may be reached where objectives and principles that fit one business (or group of businesses) endanger another."

To solve this would be a rewarding investment.

ACKNOWLEDGMENTS

The author wishes to express his appreciation of the assistance received from many sources including Mr. R. Neville, Mrs. D. Crockford, Miss J. Garfield and Mrs. P. M. Forrest of the Research and Development Department of Rubery, Owen & Co. Ltd., and in particular Mr. P. S. Walkins, Librarian and Information Officer of that department. He would thank his colleagues for many informative discussions and finally Mr. A. G. B. Owen, C.B.E., Chairman of Rubery, Owen & Co. Ltd., for unfailing support and encouragement.

The author would emphasise that in spite of the assistance received from many sources all the views and opinions expressed are his sole responsibility and do not reflect necessarily either those of the Institution or of his company.

REFERENCES

1. Meyer, M. L. "Research Versus Trial and Error." The Engineer, Volume 195, No. 5097, 29 May, 1953. Pages 770 - 772.
2. Bull, Lt.-Col. W. "A Brief History of Artillery up to the Fifteenth Century." Journal of the Royal Electrical and Mechanical Engineers, Volume 3, No. 1, January, 1955. Pages 25 - 29.
3. Hertz, D. B. "Theory and Practice of Industrial Research." New York, McGraw-Hill, 1950.
4. "The Organisation of Applied Research in Europe, the United States and Canada." Paris, The Organisation for European Economic Co-operation, April, 1954. Report of Technical Assistance Missions, Nos. 81, 82 and 83.
   Volume 1. A Comparative Study.
   Volume 2. Applied Research in Europe.
   Volume 3. Applied Research in the United States and Canada.
5. "A Brief Review of Science and Technology in Western Germany." H.M.S.O. (for the Department of Scientific and Industrial Research), 1955.
6. "The Organisation of Applied Research in Europe." Proceedings of the conference held at Nancy, 11 - 13 October, 1954. Paris, The Organisation for European Economic C-operation, June, 1955. Project No. 191.
7. "Shortages and Surpluses of Highly Qualified Scientists and Engineers in Western Europe"; a report by the Manpower Committee. Paris, The Organisation for European Economic Co-operation, November, 1955.
8. "Industry and Science"; a study of their relationship based on a survey of firms in the Greater Manchester area carried out by the Manchester Joint Research Council, 1950 - 1953. Manchester University Press, 1954.
9. British Commonwealth Scientific Office (North America). Notes on science in the U.S.A., 1954. H.M.S.O., 1955.
10. "Scientific and Technical Research in British Industry"; a statistical survey by the Industrial Research Secretariat of the F.B.I. Federation of British Industries, July, 1947.
11. "Research and Development in British Industry"; a survey of expenditure on industrial research and development in the year 1950 - 1951 made by the F.B.I. Industrial Research Committee. Federation of British Industries, July, 1952.
12. Report of the Conference of Industrial Research Directors and Managers; organised by the F.B.I. Industrial Research Committee and held at Ashorne Hill, Leamington Spa, Warwickshire, 11 - 14 March, 1949. Federation of British Industries, 1949.
    "The Planning and Financial Control of Industrial Research"; Report of the Second Conference of Industrial Research Directors and Managers, organised by the F.B.I. Industrial Research Committee and held at Ashorne Hill, Leamington Spa, Warwickshire, 10 - 12 November, 1950. Federation of British Industries, 1951.
    "The Commercial Utilisation of Research Results"; Report of the Third Conference of Industrial Research Directors and Managers, organised by the F.B.I. Industrial Research Committee and held at Ashorne Hill, Leamington Spa, Warwickshire, 17 - 19 April, 1953. Federation of British Industries, April, 1953.
    "The Education and Training of Graduate Staff for Industrial Research"; Report of the Fourth Conference of Industrial Research Directors and Managers, organised by the F.B.I. Industrial Research Committee and held at Ashorne Hill, Leamington Spa, Warwickshire, 29 April - 1 May, 1955. Federation of British Industries, September, 1955.
13. Department of Scientific and Industrial Research. "Report for the year 1952 - 1953." H.M.S.O., 1954. Cmd. 9083.
14. Department of Scientific and Industrial Research. "Report for the year, 1953 - 1954." H.M.S.O., 1955. Cmd. 9386.
15. Department of Scientific and Industrial Research. "Scientific Research in British Universities, 1954 - 1955." H.M.S.O., 1955.
16. Department of Scientific and Industrial Research. "Report for the year, 1954 - 1955." H.M.S.O., 1956. Cmd. 9690.
17. T.I.D.U. — Technical Information and Documents Unit — is one of the two main services maintained by the Intelligence and Information Division of the D.S.I.R. at its Headquarters, 15 Regent Street, London, S.W.1.
18. C.O.I. — Central Office of Information — Norgeby House, 83 Baker Street, London, W.1.
19. "Research for Industry." First article of a series "Services to Productivity". Target, Volume 7, No. 8, August - September, 1954, and subsequent issues.
20. Department of Scientific and Industrial Research. List of grant-aided research associations and research councils. October, 1955. (Duplicated list, as amended up to March, 1956.)
21. "The British Imperial Calendar and Civil Service List, 1956." H.M.S.O., 1956.
22. Dearborn, DeW. C. (and others). "Spending for Industrial Research 1951 - 1952." Harvard University, Graduate School of Business Administration, Division of Research, 1953.
23. U.S. Department of Labor. "Scientific Research and Development in American Industry"; a study of manpower and costs. U.S. Government Printing Office (for U.S. Department of Labor), c.1953. Bulletin No. 1148.
24. "Research for Industry." A supplement to the Economist, Volume 170, No. 5782. 19 June, 1954.
25. Scott, J. D. and Hughes R. "The Administration of War Production." H.M.S.O. and Longmans, Green, 1955.
26. Fincher, C. "Organisation of Defence Research in Britain." Nature, Volume 177, No. 4502. 11 February, 1956. Pages 251 - 252.
27. "D.S.I.R. Grant-Aided Research Associations Selected Publications; a Guide for Librarians." Department of Scientific and Industrial Research, 1955.
28. Heath, H. F. and Hetherington, A. L. "Industrial Research and Development in the United Kingdom; a survey." Faber and Faber, 1946.
29. Edwards, R. S. "Co-operative Industrial Research"; a study of the economic aspects of the research associations grant-aided by the Department of Scientific and Industrial Research. Pitman, 1950.
30. Connell, V. (ed.). "The Application of the Results of Research." (Report of the British Commonwealth Scientific Conference, 1946.) Butterworth, 1954.
31. King, A. "Science in the Small Firm." Research, Volume 5, No. 10, October, 1952. Pages 464 - 468.
32. Kington, C. N. "Co-operative Research for the Smallest Firms." Metal Treatment and Drop Forging, Volume 22, No. 120, September, 1955. Pages 375 - 383 and 386.
33. Kington, C. N. "Application of Research to an Industry Composed of Small Firms." Metal Treatment and Drop Forging, Volume 20, No. 99, December, 1953. Pages 597 - 603.
34. Benton, W. E. "The Functions of a Research Department in a Small Firm." British Institute of Management, August, 1951. Production Management Series No. 3.
35. Private conversations between Research Managers on 24 March, 1956.
36. White, T. A. Blanco-. "Patents for Inventions and the Registration of Industrial Designs." 2nd edition, Stevens, 1955.
37. ibid. Page 7.
38. Monopolies and Restrictive Practices (Inquiry and Control) Act, (11 and 12 Geo. 6, c. 66), ss. 3, 4, 5, 10 and 20. H.M.S.O., 1948.
39. Development of Inventions Act, (2, and 3 Eliz. 2, c. 20). H.M.S.O., 1954.

40. National Research Development Corporation. Report for the year, 1953 - 1954. H.M.S.O., 1955. H.C. 27 — 1954 - 1955.
41. Hallsworth, H. B., Griffiths, N. J. and Spear P. " A New Mechanical Foundry " ; a survey of the Hallsworth automatic moulding system (to be published mid - 1956).
42. British Standards Institution. " Adjustable Steel Shelving (angle post type)." March, 1955. B.S. 826 : 1955.
43. " The Automatic Factory — What Does it Mean ? " ; report of the conference held at Margate, 16 - 19 June, 1955. Institution of Production Engineers, 1955.
44. Ferranti Limited. " The Computor Control of Machine Tools." (Duplicated Report) n.d.
45. Sper, P., Robinson, I. R. and Wolfe, K. J. B. " The Influence of Machining and Grinding Methods on the Mechanical and Physical Conditions of Metal Surfaces." Institute of Metals. " Properties of Metallic Surfaces." Monograph No. 13, November, 1952. Pages 59 - 100.
46. Spear, P., Robinson, I. R. and Wolfe, K. J. B. " A Comparison of Twist Drills Manufactured from Standard and Special High-speed Steels." Metal Treatment and Drop Forging, Volume 19, No. 82, July, 1952. Pages 293 - 301.
47. Wolfe, K. J. B. and Robinson, J. R. " The Effect of Manganese Segregations on Machinability." Metallurgia, Volume 43, No. 255, January, 1951. Pages 3 - 7.
48. Institute of Metals. Symposium on " The Final Forming and Shaping of Wrought Non-ferrous Metals ". London, 12 April, 1956.
49. Galloway, D. F. " The Machining Properties of Non-ferrous Metals." Paper No. 1670. Journal of the Institute of Metals, Volume 84, No. 6, February, 1956. Pages 121 - 131.
50. Wolfe, K. J. B. and Spear, P. " Machining Austenitic and Ferritic Gas Turbine Steels." Iron and Steel Institute. " A symposium on High Temperature Steels and Alloys for Gas Turbines." Special Report No. 43, July, 1952. Pages 233 - 242.
51. Rockwell, W. F. " The Executive's Responsibility to Stimulate Research and Product Development." Mid-West Engineer, Volume 6, September, 1953. Pages 7 - 9. (Also, A.S.M.E. Paper 53 - MGT - 1.)
52. " Management Problems in a Research Organisation." A series of articles, Product Engineering, Volume 24, No. 6, June, 1953, and subsequent issues.
53. Hertz, D. B. (ed.). " Costs, Budgeting and Economics of Industrial Research." Proceedings of the First Annual Conference on Industrial Research, June, 1950. Sponsored by the Department of Industrial Engineering, Columbia University, New York, King's Crown Press, 1951.
54. Halsbury, Earl of. " Strategy of Research." Research, Volume 7, No. 12, December, 1954. Pages 476 - 482.
55. Gillings, D. W. " Research on Established Processes." Research, Volume 8, No. 1, January, 1955. Pages 2-7.
56. Furnas, C. C. " Research in Industry; its organisation and management." New York, Van Nostrand, 1948.
57. Anthony, R. N. " Management Controls in Industrial Research Organisations." Harvard University, Graduate School of Business Administration, Division of Research.
58. Dunsheath, P. (ed.). " Industrial Research 1956/1957." 3rd edition, London, Vallancey Press, 1956.
59. Chesters, J. H. " Organisation and Application of Scientific Research in Industry." Industrial Management, a course of lectures given at Cambridge University for the Faculty Board of Engineering, 1953. No. 5. Sheffield, United Steel Companies Limited, 1954. Pages 67 - 89.
60. Rubenstein, A. H. (ed.). " Co-ordination Control and Financing of Industrial Research." Proceedings of the Fifth Annual Conference on Industrial Research, June, 1954, with selected Papers from the Fourth Conference, June, 1953. Sponsored by the Department of Industrial Engineering, Columbia University. New York, King's Crown Press, 1955.
61. The Royal Society Scientific Information Conference, 21 June - 2 July, 1948. Report and Papers submitted. The Royal Society, 1948.
62. Evans, A. B., " Training the Library User." Aslib Proceedings, Volume 3, No. 4, November, 1952. Pages 239 - 241.
63. " Thomas' Register of American Manufacturers "; 45th edition, 1955. 4 Volumes and Index, New York, Thomas Publishing Company, 1955.
64. " World List of Scientific Periodicals Published in the Years 1900 - 1950." Edited by W. A. Smith and others. 3rd edition. Butterworth, 1952.
65. Lamb, J. P. " Commercial and Technical Libraries." Allen and Unwin and the Library Association, 1955.
66. Publications of the Research Committee of the Institution of Production Engineers :-
   (a) " Interim Report on Measurement of Productivity." December, 1949. (Issued by the Joint Committee of the Institution of Production Engineers and The Institute of Cost and Works Accountants.)
   (b) " Measurement of Productivity — Applications and Limitations." October, 1951. (Issued by the Joint Committee of the Institute of Cost and Works Accountants and the Institution of Production Engineers.)
   (c) " Measurement of Productivity — Work Study Application and Training." 2nd edition, November, 1952. (Issued by the Joint Committee of the Institute of Cost and Works Accountants and the Institution of Production Engineers.)
   (d) " Production Control and Related Works Statistics." January, 1956. (Issued by the Joint Committee of the Institute of Cost and Works Accountants and the Institution of Production Engineers.)
   (e) " A Review of Materials Handling in British Manufacturing Industries." October, 1953.
   (f) " As the Spirit Moves "—Case Studies in Materials Handling (in collaboration with the British Productivity Council), January, 1953.
   (g) " Material Utilisation in the Metal Working Industries." August, 1955.
67. Goodeve, Sir C. " Using Science to Reach Decisions." The Manager, Volume 21, No. 5, May, 1953. Pages 257 - 263.
68. Goodeve, Sir C. " Operational Research as a Science." Journal of the Operational Research Society of America, Volume 1, No. 4, August, 1953. Pages 166 - 180.
69. Institute for Engineering Production, University of Birmingham. Programme for 11th Senior Executive Course on " Operational Research ", 9 - 20 April, 1956. (Duplicated.)
70. Michaelis, A. R. " Research Films." The British Journal of Photography, Volume 103, No. 4994. 3 February, 1956. Pages 52 - 57.
71. Cullwick, E. G. " Engineering Education and the Universities." Research, Volume 5, No. 7, July, 1952. Pages 297 - 303.
72. Giffen, E., Davies, V. C. and Nixon, J. H. R. " Co-operation in Engineering Research between Educational Institutions and Industry." Proceedings of the Institution of Mechanical Engineers, Volume 169, No. 27, 1955. Pages 445 - 461.
73. Drucker, P. F. " The Practice of Management." Heinemann, 1955.

NOTE: No re-edited version of this Paper may be published without permission of the author, who would, however, be pleased to offer any facilities required.

INVESTING IN AUTOMATION

by Dr. ALEXANDER KING, C.B.E., D.Sc.

Dr. King was born in Glasgow and educated in London and Munich. He was Demonstrator and later Senior Lecturer in Physical Chemistry at Imperial College, London University.

He entered the Civil Service during the War and after service in the Ministry of Production, went to Washington for five years as Scientific Attache and head of the United Kingdom Scientific Mission. He returned to England in 1947 to be the first head of the Scientific Secretariat of the Office of the Lord President of the Council. He joined D.S.I.R. in 1950, in charge of the Intelligence and Overseas Scientific Liaison Divisions. His work for the past eight years has been intimately connected with the productivity drive, and he is chairman of the Productivity and Applied Research Committee, the governing body of the European Productivity Agency.

Dr. King's Division of D.S.I.R. has recently been responsible for the publication of a Survey of Automation.

Dr. King

I—THE TECHNICAL TRENDS

THE term automation expresses a collection of concepts and developments and is understood differently by different people. It does not represent a single easily-identifiable development, but refers mainly to three quite separate streams of technological progress. One of these is the present rapid extension of traditional mechanisation, through the use of transfer machines and advanced techniques of assembly and mechanical handling. The second stream is that of automatic control, which has developed extensively in the chemical and oil refining industries in which production is controlled by self-correcting mechanisms, frequently electronic in nature, which maintain at a constant level, particular physical or chemical properties. The third tributary consists of the application of the electronic digital computer to the automatic processing of data of all kinds and particularly of business information.

Each of these streams of development contains much that is traditional and much that is novel. The use of the term " automation " to refer to these groups of development as a whole is valuable in focussing attention on a complex and rapidly developing phase of technology, but it has a special significance because where these developments are considered together, and especially where they operate together, they constitute something completely new—the possibility of integrating automatic production in which whole processes and eventually complete systems of factory operation can be brought within the scope of automatic control. In such a concept of full automation, individual production lines would be integrated and controlled by the electronic digital computer and the various working operations made automatic by equipment that is available today.

The completely automatic factory based on the above concept is for the future; current progress towards it lies mainly in the three separate tributary streams of technical development. Nevertheless, it is of importance that the concept as a whole, together with its constituent parts, should be considered now because of the implications they have for management and labour. The rate of introduction of automation may indeed be controlled more by problems of management, economic considerations, the need for changing skills and acceptability by labour, than by purely technological factors. It should be realised, moreover, that these problems raised by the concept of automation are inherent in our complex and rapidly changing technology in general. It is particularly useful, therefore, to discuss economic and social consequences of automation because of their still wider significance for the evolving production economy as a whole.

In this introductory section the individual trends which constitute automation are described briefly under the following headings :—

1. The expanding mechanisation ;
2. The spread of automatic process and product control ;
3. The use of the electronic digital computer for business purposes.

The Expanding Mechanisation

Semi-automatic machines were invented early in the history of mechanisation : for instance, those used in carding, drafting, spinning and weaving textiles, and later on, the lathes widely employed in engineering. At the present time there are numerous semi-automatic machines such as continuous casting machines and bottling machines—in which operation is substantially automatic. Undoubtedly, the most important of these are the machine tools of the engineering industry.

In engineering, machine tools have gradually evolved and taken over more of the work of the human operator. The mass production machine tool requires only semi-skilled workers, who are predominantly concerned with loading and unloading, starting and stopping the machine. It was a fairly logical next-step to build automatic transfer between operations into the machine—and the transfer-line is the result.

The transfer-machine has been widely acclaimed in the popular press as ushering in the automatic factory. Everyone who has seen transfer-lines in a motor-car factory will confirm that the transfer machine, whilst a significant and interesting development, only goes a very small way to achieving the fully automatic factory. Even if transfer machining becomes wide-spread, it is not likely of itself to transform the face of factories as we know them, since it can only be applied to relatively few of the operations that go on in, say, a motor-car factory.

Nevertheless, transfer-machining has many possible applications. The principle has been widely applied to milling, drilling, tapping and broaching machines, especially in the motor-car factories of the U.S.A., Russia, and some European countries. In principle there is no reason why it should not be used in any industry with a large and steady demand for components of standard design. But the extent to which this is likely to happen depends primarily on the existence of long production runs, without which the transfer-machine cannot be economically justified. As far as Britain is concerned, therefore, the size of the markets for which we are producing may well be the limiting factor, since the cost of the transfer-machine cannot be written off so quickly as in the U.S.A., for example. However, French and British production engineers have concentrated on transfer-lines made up of standard units, so that they can be modified relatively inexpensively to suit changes in the design of the product. Undoubtedly this is the best line of approach for our own special conditions, and it may enable us to use these techniques for shorter production runs than is possible with the highly-specialised transfer-machine.

The transfer-machine is no use for producing small runs of components of diverse and complicated shape. This job is usually done by a versatile machine tool that will follow a profile. The control of such machine tools by electronic computers is now developing rapidly and the first applications of the technique to production tasks are now taking place. The ultimate field of computer-controlled machine tools is probably in small-quantity production, and more especially in the tool-rooms of large engineering concerns. They are unlikely to play any part in mass production except where parts of very complicated shape must be produced within limits of accuracy that are too fine to be achieved by direct forging and casting (e.g. the rotor and stator-blades for the hot ends of gas turbines).

Computer-controlled machine tools are really innovations in control rather than operation, and are therefore beyond the field that can properly be attributed to mechanisation. The inspiration behind them comes from the control engineers and they are a good example of how principles of control engineering, which in the past have been mainly applied in the chemical and petroleum industries, are becoming applied to problems of metal cutting. This blurring of the line between the fields of automatic control and traditional mechanisation is an important feature of automation as it is now developing.

The developments in machining discussed above are the main element in the present expansion of mechanisation. But mechanical principles have also been fruitfully applied to problems of handling and assembling components automatically, and the solution of these problems will play an important part in extending the future scope of automation.

Progress in handling has been particularly marked in recent years. In the chemical industries indeed, progress towards automatic production has developed very rapidly because of the ease with which liquids and gases can be made to flow by gravity or pumping from one process to the next. This has been extended to some extent by making solids behave like fluids, thereby greatly simplifying the problem of moving them. They can be dissolved or suspended in a liquid, or made into a paste, or so finely divided that they flow. In these states gravity or pumping can easily achieve automatic movement between the processing operations. The metal components in engineering factories are, of course, an especially difficult problem ; only the smallest of them, for example, nuts and bolts, can be made to flow. However, the heavier components can be moved by power conveyors incorporating the latest principles of mechanical handling. More difficult than the achievement of automatic movement as such is the co-ordination of flow of components and parts. At present this is usually done by human operators, but simple electronic computers are beginning to be used for this purpose.

As for assembly proper, progress is still slow. There are, of course, many mechanical devices that automatically bring and fix components of simple shape together, for example in the assembly of modern doors, chassis-frames and engine parts, the capping of bottles and the manufacture of electric lamps.

Their scope and use will probably be increased in the future. But assembly problems are usually more complicated, involving delicate manipulation and adjustment. Only a complex and costly automatic control mechanism could compete with the brain and human hands on such tasks. It is far more likely that the assembly problem will be brought within the scope of simple mechanical techniques of the re-design of components specially for this purpose. This has already happened in the assembly of electrical circuits for radio and television sets.

The Spread of Automatic Process and Product Control

Automatic control is based on instruments that measure how far the physical or chemical state of a system varies from a desired value ; and on the use of this information to restore the system to the desired state. There is no new principle in this. The steam-engine has had a governor since the days of James Watt and a patent was filed for the first pressure-cooker as long ago as 1680. The automatic pilot was flying aircraft in 1925 and before the last war automatic control was being developed in many industries, notably chemicals.

The process-control systems found in most factories consist of four basic units ; the plant and the process, the measuring unit, the controlling unit and the correcting unit.

The measuring unit detects and measures the value of controlled conditions (usually physical quantities) in a plant or process. The value of the temperature, to take one common variable, is transmitted to the controlling unit, which automatically compares it with the desired and pre-selected temperature. Whenever these values differ, a signal is sent to the correcting unit which alters an appropriate setting—of a steam-valve, perhaps—and brings the actual temperature back to the desired value. The plant itself forms an integral part of a closed loop.

Automatic control techniques have found their main application in the process industries such as chemicals, petroleum refining, iron and steel, cement, paper, printing, food and brewing. In fact, it is probable that many of them could not exist and certain that none could have reached its present state of development without automatic control. There are probably two reasons for this. First, it is not difficult in these industries to organise production as a continuous-flow process. Second, the quality of the product is closely related to a certain simple physical property (such as temperature, pressure, rate of flow) that can be easily measured. In other industries it is extremely difficult to develop measuring units. Manufacturers and customers often judge the quality of a product on what appears to be a crude subjective basis. The textile industries are a good example. It is possible to measure and control conditions like drafting, moisture content, the tension of threads during weaving, and the rate at which yarn and cloth are dried; but the relationship of these conditions to weaving properties and to the quality of the cloth as judged by feelings or draping ("handle" or "drape") is still not understood. It is hard to define properties like these, let alone measure them.

Thus, the absenceof suitable measuring units to a very large extent explains the present limitations to the industrial scope of automatic control. Equally, where progress in the measurement of techniques is taking place, new industrial applications are beginning to emerge. For example, the development of instruments able to count introduces the possibility of automatically sorting batches of small components in the engineering industry; those able to select colours are being used for screening peas and beans before canning. A wide range of reliable instruments for controlling process conditions and product characteristics is in fact now available; several are mentioned below to indicate the variety of possible applications outside the chemical and petroleum industries, which have been the cradle of automatic control :—

(*a*) Gauge control (in rolling sheet metal) ;
(*b*) Tension control (wire tension during drawing and testing, uniform tensions in spinning, processing of cloth and rotary printing processes) ;
(*c*) Weight control (control of dough weight in bakeries, automatic weighing millers for piston heads, automatic weighing and mixing of materials for brewing, plastic processing, concrete mixing, etc.) ;
(*d*) Diameter control (in grinding operations and in control of cable sheathing diameter, etc.) ;
(*e*) Speed control (in metal cutting operations) ;

The spread of automatic control techniques outside the process industries is an important feature of the present position in this field of automation. The computer-controlled machine tool, for example, means that the techniques of automatic control are beginning to affect the basic operation of the metal-cutting industries. If current work on the development of methods of measuring tool-wear bear fruit, these industries are likely to be fundamentally affected. But in the immediate future it seems more likely that automatic control outside the process industries will be limited to ancillary operations such as inspection and the automatic routing of components through the factory.

The main impact of automatic control will continue to be in the process industries, and will probably spread wherever production can be organised as a continuous flow of material which responds under control to changes in the conditions of production. The extent and speed of development will depend on economic factors. Usually, the economic advantages of automatic control are obtained only when it is designed as an integral part of new plants; and the greatest advances will, therefore, probably be in new plants rather than by modification of existing processes. Although such developments will be most striking in large firms able to finance by programmes of capital investment, there will be a steady increase in the extent of automatic control in individual processes even in the smaller firms.

The Advent of the Electronic Digital Computer in Business Offices

The forerunner of modern mechanical office equipment was the adding machine, invented by Blaise Pascal in 1642, but not produced commercially until 1873. The machine saved time and eliminated

arithmetical errors ; but mistakes could still be made when feeding figures to the machine or when recording results. In the twentieth century specialised adding machines have been evolved to fit different accounting needs. The cash-register, for instance, records individual sales and the cash they bring in. Many specialised book-keeping machines have been produced and punched-card systems were first used on machines of this type, though they have since been put to many other purposes. With punched-card systems, information is punched on individual cards and mechanically arranged, tabulated and printed in any desired manner and more cheaply and quickly than by previous methods. Punched-card systems are undoubtedly the half-way stage between old-fashioned clerical work and a development that brings office work within the scope of automation—the modern electronic computer. These computers rapidly and automatically analyse information, and can often carry out a wide variety of clerical tasks, thereby making the automatic office a real possibility.

The term " electronic digital computer " covers many devices doing a variety of work. Electronic digital computers may be specially designed to undertake a specific type of problem, or they may be general-purpose machines. Some of the first applications were with machines of the special-purpose type, but large companies tend at present to install multi-purpose computers which can accomplish a variety of tasks.

Progress in using such machines has been especially rapid in the U.S.A. The International Business Machines Corporation and Remington Rand already produce large digital computers that are specifically designed for clerical operations—the IBM 702 and 505 and the modified Univac. Remington Rand has installed fifteen Univac machines in the U.S.A. and more are on order. Eight of the existing installations are in Federal Government agencies while seven are hired to business and industrial firms, among them the General Electric Company (USA), Sylvania Electrical Products, the Metropolitan Life Insurance Company, the Franklin Life Insurance Company, the United States Steel Corporation (two installations) and the Chesapeake and Ohio Railway. Eighteen large IBM machines have been installed by industrial users, such as the Chrysler Corporation, the Ford Motor Company and the Monsanto Chemical Company. It is reported that a hundred more machines have been ordered.

In Europe, technical progress in the computer field has also been rapid, even though the number of applications to office tasks is so far small. In the United Kingdom several firms, including the British Machine Company, Powers-Samas Accounting Machines, Elliott Bros. (London), the Plessey Company and IBM United Kingdom, are producing small electronic computers. Some of these machines are not really computers but calculating machines. They are very suitable for use in conjunction with existing equipment, such as punched-card records, sorters and collators. To take one example, a Powers-Samas electronic multiplying punch was installed by British Railways at Crewe in January 1955 and is used for problems of documentation and for control of stock. Each calculation is done separately by two different electronic circuits and only if the answers are identical are the results printed for action.

The most outstanding European example of a general purpose electronic digital computer used to do clerical work is probably the LEO of Joseph Lyons and Company Limited in the United Kingdom. The computer, called LEO after the initials of its full name, " Lyons' Electronic Office ", started in January 1954 to prepare the pay-roll for one department of 1,700 employees. With further experience LEO proved itself very reliable and was given more work to do. It now calculates the pay-roll for 10,000 employees in about four hours instead of thirty-seven full-time clerks under supervision using orthodox office machinery. Towards the end of 1955, it began to work out the pay-roll for the employees of an additional large company.

LEO also handles the daily orders to the bakeries from more than 150 Lyons teashops. Every afternoon it prepares all the data and records relating to production, assembly, packing, despatch, cost accounting and other processes. Final revisions are received by telephone before 3.30 p.m. and the job is completed by 4.45 p.m.

After accomplishing all these tasks, LEO still has time for a variety of contract work for outside companies.

The amount that LEO can save in clerical costs depends largely on the nature of its work but, according to one estimate, it could easily be £100,000 a year and might be considerably more. A new machine, LEO II, has recently been designed : it can work four times as fast as LEO I and should be even more reliable. Its capital cost will be about £75,000.

Electronic digital computers employed on clerical work, such as those described, are as yet few and far between. This should not be forgotten. We are only at the beginning of the application of electronic computing devices to routine clerical work. Nevertheless, it is a striking fact that less than ten years after the completion of the first electronic digital computer in the U.S.A., all the main manufacturers of business accounting machinery in France, the United Kingdom and the U.S.A. are entering the field.

Not enough is known about the economics of the electronic computers in offices to predict their future uses with any certainty. However, they are likely to be employed wherever rapid analysis of masses of routine information is necessary. Any large manufacturing company is likely to have sufficient work of this nature to justify an electronic computer of some sort. The industries most likely to be affected in the near future are those where the routine analysis of information is a central feature, for example banking and insurance. Small firms will be able to make use of hire services provided by manufacturers of computers.

Thus, there can be little doubt that the electronic digital computer has an important future in business offices. The rate of introduction of computers will, however, be controlled less by the cost of the equipment than by the necessity for re-planning of office

procedure involving the careful study and reformulation of existing office routines, with all the obstacles and delays that they may incur.

Apart from the automation of large routine offices, computers are likely to have a major use in marketing and distribution and in the operation of transport systems.

II.—AUTOMATION AND THE ECONOMY

Automation has a particular significance for countries such as this, possessing a highly developed industry and dependent on export trade. Changes in the pattern of industry and of exports over the past few decades have shown that we are more and more dependent on those industries which produce capital or consumer goods of a sophisticated type, containing a high added value in terms of skill, workmanship and science to the imported raw materials from which they are manufactured. In fact, over a period, rate of technical innovation is likely to be the main factor controlling our productivity level. Furthermore, we are enjoying a period of full employment, so that further expansion of our production depends on a better deployment of labour and skill. Rapid introduction of automation thus offers an obvious means of improving the economy and if well planned is likely to attract the support of all sections of the community. The impact of automation will bring with it economic and social problems of a type common to all technical changes in which labour is replaced by plant.

There is, however, one new element in the situation we are now encountering—the greatly increased speed of technical development. In the past, innovations have been established slowly. The initial mechanisation of the cotton industry took some 70 years, and it took about a century for industry to adopt the steam engine anywhere near fully. Only a fraction of that time is needed for developments of similar importance today, such as turbo-jet engines in aircraft and synthetic fibres like nylon or terylene. It is to this phenomenon of rapid technological change, rather than automation as such, that we need to adjust our thinking. What is required is a body of ideas and techniques of an economic and social character which will enable automation, in common with other major technological developments, to be introduced smoothly and rapidly without the social costs which have accompanied rapid change in production techniques in the past.

The rapid development of automation and of technology generally has suggested to many that the world is entering a period of plenty in which the supply of goods will increase so rapidly that it might become difficult to find sufficient consumers. This is hardly supported by present trends which show that in this country and even in U.S.A. the output per worker is still increasing sufficiently slowly to allow ample possibility of adjustment of economic and consumption patterns to the new circumstances.

The Extent and Pace of Change

The most important question to be answered is how far and how fast is automation likely to go. We can only guess. The above analysis of the technical trends suggests that the technical and economic advantages of techniques of automatic production are such as to assure it a wide potential field of use.

But do not these advantages only occur when products are produced on a large scale? If so, the majority of British firms would be ruled out. Full automation would probably depend on long runs of production in most cases and obviously, the dependence of some kinds of partial automation (e.g. transfer machines) on long runs of product, and the difficulty of adapting it to changes in product design, favour the large firms catering for big, steady demand for products of standard design. But automation is not always as dependent on economies of scale as is sometimes suggested. Some kinds of automatic equipment (e.g. the computer-controlled machine tool and to some extent process-control mechanisms) are inherently flexible, and can be adapted to changes of product. The high capital cost of much automatic equipment obviously presents a problem to the smaller firms, but it need not rule them out completely since this cost varies widely with the different form of equipment, some of which is not beyond the financial resources of smaller firms. This is particularly true of the processing industries where automatic units need not always be much more costly than conventional plant. Moreover, it may be possible for medium and small firms to get the long production runs required by simultaneously studying methods of production and the pattern of orders with a view to standardisation. In some industries, for example aircraft and cars, the small specialist firms producing a small range of components may be in a favourable position, since they usually produce those components in larger quantities than would the manufacturer of the final product if he made the components himself. Thus, although automation is more likely to concern large firms, it certainly cannot be ruled out as irrelevant to the medium and small firms that predominate in Britain.

A second feature of the probable future extent of automation is that it is most likely to be introduced by industries and firms that are expanding their output, and particularly those which are re-equipping to do so. The reason is that contracting firms and industries are unlikely to have the material resources to invest in automation and the zest to re-think their processes to the extent required. On the other hand, it is conceivable that rationalisation of a contracting industry, such as a branch of the textile industry, might be most successfully achieved by introducing a high degree of automation. It seems unlikely, however, that the " depressed " industries in Europe will either seek or find their salvation in automation.

But we have so far only discussed half, and the less important half, of our question. Given a wide scope for automation we still need to know at what rate the material and human resources necessary for its growth can be made available.

First, capital. It is usually assumed that automatic equipment will cost more than the converted machines to produce equal output. This is by no means true in particular cases. Nevertheless, automation *is* likely to increase the rate of expenditure on capital goods because machinery has to be replaced

more often whenever rapid advances are being made in techniques; and also because the increased production that goes hand-in-hand with automation implies the use of more machinery. Even so, since a relatively small proportion of the national product is spent on industrial plant, the increase needed for automation could probably be met from the expanding national product, without halting the rise (in absolute, not proportional terms) in the volume of expenditure for other purposes. Thus, in terms of national accounting, there should be no difficulty in finding enough resources for automation. Of course, this is merely to say that the economy should have sufficient resilience to support a rapid spread of automation. It does not mean that the industrial assessment of the situation by individual firms will lead to this capacity for automation being realised; some may be discouraged by their assessment of future markets. But since in any case automation is likely to be taken up by expanding, aggressive companies, it seems unlikely that they will fail to finance development from their own reserves, or, alternatively, make a successful bid for the necessary backing on the capital market. All in all, we come to the conclusion that shortage of capital is unlikely to hinder the spread of automation on a scale that can be justified on other economic grounds and is possible for practical reasons.

What of machinery or materials? Obviously more automation means more capital equipment, and there could be a shortage of machinery for automation even though there are sufficient funds to buy it. Again, we may run into shortages of materials such as steel, or into a bottleneck in electricity supply for industrial purposes. All these are possibilities. Any expanding economy is bound to be working near the limit of availability of some physical resources. But it is surprising how much an urgent demand—reflected in prices—calls them into being for essential purposes.

This is much less true of man power. In the United Kingdom we are already faced by a chronic shortage of technologists and scientists. Automation will have to compete with pressing claims from education, defence, atomic energy and many other important developments in industry. Resources of skilled technical manpower are very inelastic because of the long period of training required. Indeed, the very limitation to an expansion of automation seems likely to be the one that is most difficult to overcome —manpower. For this reason alone we are unlikely to be faced by anything in the nature of a rapid general shift to automatic methods. In fact, the probability is that automation will proceed at a slower pace than is desirable on economic grounds. The likely shortage of skilled technicians and scientists and of managers with the know-how to operate automatic plants, are the main difficulties to be overcome, rather than any widespread displacement of labour.

The Effect on Industrial Structure

Advances in technology have in the past tended to concentrate production in large, highly capitalised undertakings with complex technical processes. The reason for this is that in general only such large firms can afford to employ the specialists who can apply the accumulated scientific and technical knowledge to the needs of the firm. Moreover, they can afford to finance research directed to the particular commercial objectives of the firm, and even to risk investment in research of a type from which there can be no certain return, but which on occasion leads to a really big advance in product or production technique. Automation is likely to reinforce this trend.

A secondary trend will be the growth of small firms which specialise in a limited range of components, intermediates or instruments often as a service to the manufacturer of final products. This is because size of market is a better guide than size of firm to the possible economic advantages of automation. Superficially, this second trend appears to run counter to the move in the direction of larger firms. In fact it may not. For the mutual dependence between component or machinery manufacturer and the producer of the final product will tend to lead to financial as well as contract arrangements between them. It is interesting to note, for example, that some of the large motor-car manufacturers in the U.S.A. have had to lend money to the suppliers of their machine tools to enable them to develop new automatic machinery. Such arrangements would logically follow from the fact that automation often requires steady, high levels of output, and from the economic penalties that would arise if outside suppliers were subject to delay and uncertainty.

Another feature of some importance will be changes in the cost structure of industry, in the direction of diminishing the proportion of labour in total cost. This raises the problem of the relationship of "leader" firms in an industry which has adopted the latest techniques, to those with a radically different cost structure. For example, the attitude towards wage increases would in all likelihood be somewhat different in the two cases, because the financial burden of a particular increase would be different.

Employment

The known facts concerning the effect of automation on employment can be very simply stated.

1. Automatic equipment very often brings striking savings of direct labour; savings of the order of 40-50% have been widely reported.
2. These savings only rarely seem to have resulted in workers being dismissed.

How can this be explained? Most of the firms that are likely to introduce automation can readily absorb displaced workers for two reasons. In the first place, they will probably be large firms which can transfer displaced workers to other departments or, if this is not possible, adjust the rate at which the wastage of labour is made good. Secondly, automation has made most headway in industries with expanding output, such as electronic equipment, motor vehicles, chemical products and petroleum. Because labour is scarce, labour-saving methods often provide the only way of expanding production and meeting demand.

Thus, if managements are able to plan the man-power aspects of automation, as well as the technical requirements, the dismissal of workers can often be avoided. There are, however, many questions that need study well in advance. For example, can displaced workers be absorbed elsewhere in the firm; how far will it be necessary to take advantage of the natural wastage of labour; and what training will be required to equip the workers either to operate new machines or to work in other departments. Provided such problems are well considered, and provided the trades unions concerned are brought early into consultation, so that the workers are kept informed as to how they will be affected and what is being done for them, it should be possible to introduce automation with a minimum of disturbance.

The absorption of displaced workers is, of course, much easier under conditions of full employment in the economy. In the United Kingdom for example, there has been a high level of demand for goods and services and many industries have experienced almost continuous shortages of labour. While these conditions exist, and provided that the rate at which automation is introduced does not become overwhelming, there is no reason why the introduction of automatic machinery should generally give rise to more then temporary unemployment, even when the firms introducing the machinery are themselves unable to absorb the workers who are displaced. Moreover, the increase in productivity resulting from automation will help to maintain a high level of demand insofar as it enables manufacturers to reduce prices and stimulate the demand for their goods.

Even when there are more jobs than workers, as in full employment, problems of labour transfer may arise if the skills or abilities of those displaced do not match the vacant jobs or are not immediately available in the right area. How serious these problems become will depend on the extent and character of the existing mobility of labour. The figures suggest that the normal rate at which jobs are changed is high—one change of job each year for every three workers in employment. Movement between jobs on this scale could help to soften the impact of automation; but if firms were to adopt automation on a large scale and at the same time in an industry which is heavily concentrated in a few localities, there might be acute problems of local unemployment and local shortage. It might be necessary to bring fresh industries into such areas. Special training might also be needed, if particular skills were widely affected; older workers in particular might experience difficulty in acquiring new skills.

The New Skills

The acquisition of new skills by displaced workers is an important matter. The first question is whether automation needs skills that are beyond the grasp of the existing workers. Operatives on automatic processes fall into two main groups; machine minders in the engineering and other manufacturing industries; and process-monitors, who have long existed in industries like chemicals and petroleum. A good example of the former group is the operator in charge of a transfer-machine in the motor-car industry. Such operators are semi-skilled, as were their predecessors on traditional machine tools. They have more to think about than the operator of an individual machine tool; their actions are more varied and continuous; they may cover more ground, have more points to watch, and need to react more promptly. They also have more responsibility in the sense that more scrap results from their mistakes, and consequent dislocation of production is more serious. But they do not need any very special training. Usually they can be trained on the job in a period of a few weeks. Much the same is true of the second category of operators—process monitors. For example, operators monitoring a continuous strip mill in the steel industry on which there is automatic control certainly do not need any greater skill. The work on a continuous mill is in fact less exacting physically, and calls for less skill based on experience. As far as present types of automatic equipment are concerned, the only example of a real break in operative skills seems to be the electronic computer used on office work, and even in its case the operating team can to some extent be made up of clerical workers re-trained on the job.

No general conclusions can be drawn from such cases. But it does seem unlikely that operators on automatic processes will need advanced technical training. They may need more or less skill than formerly, according to the particular process in question, but there is rarely a sharp break with existing skills.

The effect on operative skills is only one side of the problem. A more important result of automation seems to be that the proportion of operatives to other categories is considerably changed in factories where automation is extensively used.

First, it is reasonably certain that the ratio of managers, supervisors and technicians to operatives will be greater in automatic than in non-automatic plants, because processes will be more complex technically and managerial control will have to be stricter. This trend already exists and evidence of it, though fragmentary, is consistent. Moreover, the skills required of both managers and technicians will be different. In management, deeper knowledge of the technical aspects of the processes will be required; the need to use advanced techniques of planning and control so as to ensure high rates of output without costly delays will tend to increase the importance of formal training for management. The vital importance of technical decisions will mean that more technicians than in the past will have to take management responsibility. All this points in the direction of highly-trained, technically-competent professionally-conscious managements.

A second consequence is that the proportion of maintenance men to operatives rises. For example, Table I, which sets out the proportions in different categories before and after the introduction of a continuous strip mill in a British steel firm, shows that the proportion of craftsmen who directly maintain the process is more than doubled.

Table I

IMPACT OF THE INTRODUCTION OF A CONTINUOUS STRIP-MILL ON OCCUPATIONAL STRUCTURE

(*a*) *Operatives and Maintenance Craftsmen*

	Before per cent.	After per cent.
Craftsmen ...	4	10
Leading hands ...	15	7
Semi-skilled ...	55	62
Unskilled ...	12	15
Juveniles ...	14	6
Total ...	100	100

(*b*) *Managers, Supervisors, Clerical Workers and Technicians*

Increase from 10 to 14 per cent. of the total labour force.

The conclusion to which we are drawn is that if the new technical management and maintenance skills are taken into account, the general level of skill will tend to rise in the sectors of industry affected by automation. What happens to the level of skill in the working population as a whole will depend on the extent to which automation spreads, and on what happens to skills in those sectors of industry that it does not affect. (The effect of automation could be overshadowed by the influence of other developments, such as the continued spread of traditional techniques of mass-production). But on the whole it seems that the level will rise, rather than fall.

This being so, vocational training and education are likely to need close examination. Not only will it be necessary to expand facilities, and to institute new courses, but also to examine existing courses, including traditional apprenticeship schemes, to see whether they are meeting modern needs.

III.—AUTOMATION AND THE FIRM

Most of the issues raised above do, of course, have implications for individual firms. But in general they all turn on conjecture about the future scope of automation and the rate at which it will be introduced. Other effects arise in individual firms quite regardless of the general position in the economy as a whole.

Many firms that have introduced automatic techniques will admit freely that they started with much faith in the venture, but with little certain knowledge concerning its profitability. While decisions to introduce automatic processes will become easier as costing data accumulates, progress will depend during the present exploratory phase on the willingness of individual firms to take the first imaginative step. This depends in turn on the characteristics of the entrepreneur—the urge to be technically up-to-date and an optimistic assessment of future markets and trends. In the long run, however, automation will make progress wherever it has demonstrable economic advantages over existing processes and equipment. It is necessary to study cost and operation of existing automatic equipment very closely before attempting reliable forecasts of desirable trends. Indeed, it seems that information on costs could contribute more of value to the rapid acceptance of automation than further exposition of its technical possibilities. It is to be hoped, therefore, that those firms which have gained experience in automatic production will, in the national interest, make available as much cost data as the competitive position allows.

Management and Automation

The use of automatic techniques of production has three main consequences, so far as management is concerned:

(1) an increase in the *technical complexity* of production;

(2) *technical integration* within processes, which means that if one machine or process is stopped, all are stopped;

(3) *high captilisation*, with machinery taking a bigger share, and labour a smaller share, of the costs of production.

These trends result from mechanisation of all types, but are strikingly intensified by automation. They increase the responsibilities of management by requiring a heavy investment of capital and a high rate of output, by making plants inflexible in terms of what goods can be produced. The main implication for management is, in fact, the need for planning and control of a very high order.

It will be more important than ever before to plan the construction of a new plant well in advance. Each piece of equipment has to be carefully chosen with the needs of the whole organisation and lay-out in mind, because a single unsuitable unit can lower the efficiency of the whole system. The possibility of introducing automation should be considered very carefully when working out the design of a product. Consumer trends and market possibilities will have to be studied before the initial costing is done, with a view to discovering how adaptable the new equipment must be.

Planning is equally necessary once the plant is in operation, its main task being to maintain a high output by devising suitable operational programmes and changing them where necessary. There are three main tasks of organisation: to overcome the technical inflexibility which occurs in automatic plants, as in all highly integrated plants, where processes and machines are linked together; to find and operate an efficient maintenance system; and to ensure that the automatic processes run continuously.

Automation implies many important changes and additions to the functions and techniques of management and lays particular emphasis on the need for study of industrial operations, cost control and market trends. Technical knowledge and training will be expected of the manager to a much higher degree than at present, but equally human qualities of versatility and adaptability will be demanded. In common with other types of technological innovation, the complexity of the automatic factory will require the manager to be able to understand and reconcile the various skills, needs and possibilities of the ever-increasing number of specialists.

Automation and the Structure of Management

Automation in industry is not yet sufficiently widely developed to enable its influence on the structure of management to be forecast. Nevertheless the need for planning and centralisation which it brings, as well as the complex technology which is inherent in it, suggest that structural changes will be necessary. It is probable, however, that the changes will be evolutionary and gradual rather than abrupt and, indeed, many management problems which have been encountered and overcome in the process industries and in those which have complex assembly lines have already much to teach firms new to automatic production.

Automation, in common with other complex production trends, requires that scientists and technologists should find their right place in management because technical considerations affect an increasing number of policy decisions on development investment, planning and operation. There is a double need: namely, for managements to have a broad and balanced understanding of the new principles emerging from scientific and technical development, and for scientists and technologists to have more understanding of the economic and managerial factors involved in implementing their advice. It may well be that scientists and technologists will become members of the top-management team more frequently than in the past. Some functional departments are also likely to become more important than hitherto, e.g. maintenance and design. These structural adjustments are likely to be achieved more smoothly where technical departments have already an effective voice in management.

Automation may also weaken the " line and staff " principle, owing to the need for a more effective type of communication within the factory between the various technical specialists who set up the plant and correct faults in operation and also between machine-minders, maintenance personnel and technical specialists in event of a break-down. Where faults have to be remedied quickly, the machine-minder may have to use his intimate knowledge of his own piece of equipment or process and call in the correct specialist department without going through the normal points in the chain of authority on the line. In such cases the essential working link may be between operator on the line and the technician, which could modify profoundly the job of the foreman. He may be less concerned with decisions that affect production than with the keeping of records; furthermore, while his role of man-manager will still persist, it may well be less dominant owing to the very discipline of the technological process. Whatever management structure emerges must be flexible, unified and discouraging of the growth of separate and rigid functional " empires." Automation requires technical experts to be co-operative and their work geared to the production policy of the firm as a whole.

Management and Operatives

These consequences are also reflected in changes in the relationship between management and the worker. For example, the rapid communication of information about process faults—necessary if economically prohibitive delays are to be avoided—means that the operatives will tend to work more directly with technical management than in the past. Further, effective maintenance, and especially preventive maintenance, will depend on good liaison between operatives and maintenance men. To operate effectively in automatic production the worker will need a better understanding of the plant than in the past, and clearer appreciation of management objectives. In a real sense, he will need to be part and parcel of the management team, even though what he is doing may not need high skill or long training.

A second consequence is inherent in automatic working. Management objectives are not so dependent on the exertion of effort by the workers. Moreover, because the operator's job is frequently to keep watch for untoward events, rather than actually intervene in the process, the effectiveness of operations is little affected by the efficiency of his manipulation movements. For both reasons, it ceases to become an object of management attention, either to get the maximum effort from him, or to improve his manual movements. Rather, as suggested above, management looks to him for a sensible understanding of what is going on in the process, and intelligent action in the event of emergency or breakdown.

The change in the cost structure also has its implications. When direct labour is an important part of total cost, management is bound to concentrate on improvements in its efficiency; much of the technique of management has this as its aim. If automation changes the cost structure, as it does, then efficiency will tend to be sought elsewhere.

Taken together, these changes imply a somewhat different management-worker relationship: the worker on automatic processes will be less an object of management techniques than on non-automatic processes.

Conditions of Work

Remote control, whether by electronic or other means, takes the operator one step further from the chain of operations, since he need not be tied to a single operation. Thus, automation can improve physical conditions in varying degrees, the benefit being especially great in occupations, like steel-rolling, that were formerly arduous.

It may be necessary to run automatic machinery continuously, either because it is costly to shut down a plant (in the process-industries, for instance) or because the ratio of capital to labour is high and the capital equipment needs to be employed as fully as possible. A consequence will be the wider adoption of shift working, and the periodic shutting down of plant for inspection and maintenance. These developments are bound to stimulate fresh thinking about the arrangement of working hours. The best possible arrangement must depend on several factors; what period of monitoring duty is compatible with efficiency, health and safety; what are the technical requirements for continuous operation and maintenance of plant; and what effects shift-working has on domestic and community life.

Since the rate of output is decided on technical grounds, and is controlled by technicians rather than

by operatives, piece-rates based on the output of individual workers may not suit work on automatic processes. Moreover, the contribution of one operative can rarely be isolated from the contributions of others, so payment will tend to reflect the performance of a team or factory rather than that of an individual; and it may be based on criteria other than output, for example machine-utilisation. Also new techniques like job-evaluation and merit-rating will probably be more widely used for similar reasons.

Job Satisfaction

Research has shown that pace-setting of the worker by the machine is often an important source of dissatisfaction. It is neither physiologically or psychologically natural to work for long periods at a constant pace, such as is required in some mass-production plants that are highly mechanised. The operator on a fully automatic process rarely needs to adapt his speed of working to that of the machine. Usually his work consists of routine checks according to a programme which he or the management has set. Only occasionally is he called to action by the machine—when it breaks down, for instance. But in partly automatic processes the problem of pace-setting remains. One good example concerns the operator who does repetitive work between two automatic machines, which require work to be removed and fed respectively, both at fixed intervals. Another example is the monitoring of processes, where the worker has to close the control-loop and in doing so to act on a continuous flow of signals. In such cases the worker is tied to the process and may suffer boredom and fatigue, especially where the task, though simple and repetitive, calls for constant attention.

The more a process becomes automatic, without actually completing the change, the greater is the likelihood of dissatisfaction due to pace-setting by the machine. But this trend seems to be reversed when processes become fully automatic, since the worker is no longer immediately involved in the chain of operations on the product.

IV.—CONCLUSIONS

Automation is a convenient term to express three separate lines of technological development, namely, mechanisation, automatic control and the use of the electronic computer, which are converging to make possible in the future, completely automatic production. Full automation will not be achieved on a wide scale for many years to come, but advances in each of these three streams of progress and in their integration are rapid and sufficiently novel to constitute a new phase of industrial evolution.

Some of the technical trends can be foreseen clearly. The production of handling and assembly of components will be steadily mechanised and transfer machines will be ever more widely used in the mass production of engineering components. The automatic control processes, already far advanced in great industries like petroleum or chemicals, will continue to make progress and to extend to other manufactures. Electronic computers will provide an increasing service to management, at first through routine clerical work, later in problems of distribution, marketing and transportation and then again in controlling processes and machinery to enable that integration of control to be achieved which must precede the establishment of the automatic factory. It is likely, indeed, that in the next decade, the most striking results will be achieved by extending use of computers.

Automation is of particular importance to this country with its limited labour force, its dependence on exports and its need to manufacture and sell goods with a high content of science and skill. Automation, if intelligently applied, offers one of the best possibilities to us to increase the general productivity of industry and to maintain prices at a competitive level. At the same time it can contribute to the increase of living standards.

It seems clear then, that the impact of automation will gradually increase during the next decade or two, although many industries will probably be only indirectly affected. The benefits will be most obvious to large firms in expanding industries, although many small specialist firms are well suited on both economic and technical grounds to automatic working.

The factors controlling the rate of introduction of automation are economic, social and psychological rather than technical and much information and, indeed, research is required if difficulties are to be overcome. Firstly, and most importantly, automation has need for well-trained and enterprising management. The most important brake on progress will almost certainly be the existing and prospective shortage of technologists and managers. It takes longer to train a first-class technologist than it does to build a modern factory or atomic power station. Automation both increases the need for them and requires of them more in the way of qualifications, skill and judgment. It will necessitate the expansion of training facilities within the educational systems and a reassessment of the needs they serve, which needs frequently cut across the existing boundaries of professional training. Automation implies also that firms should seek to promote and train the potential managers and technologists still in the ranks. Qualities such as versatility, adaptability and a capacity for understanding other viewpoints and the significance of special skills, would look like being increasingly valued in managers and professional staff.

Automation, like all major innovations, entails great risks and at each stage firms must have the imagination and resolution to take sensible risks and to act when only informed guesswork can help. There is an urgent need for comparative information on capital and running costs of automatic and conventional equipment to make a balanced judgment possible on whether to innovate. Progress with automation will also depend on how readily individual firms can raise capital for development. On the national scale, capital should not be short for rates of development now envisaged; large firms should be able to save or raise all they need, especially in industries of expanding output. Scarcity of fuel,

certain materials and some types of machinery may be generally felt.

At present there is much concern with the possibility of automation causing unemployment. This is unlikely to be a serious problem if its introduction is not too rapid and shortage of technologists will probably make sure of that. Furthermore, within the individual firm it can be avoided by keeping redundancies to a minimum so that with full employment, redundant workers can be quickly re-absorbed. It is, however, of the greatest importance that trades unions should be consulted at every step and well in advance of the introduction of automation and, that due attention be paid to the needs, feelings and problems of the workers concerned.

Changes in operative skills will also be made more smoothly if they are carefully planned, if provision is made for on-the-job training and if workers are consulted and informed of future developments. There may be some difficulties in acquiring new skills, especially for older workers.

Automation will have many other social consequences; it will necessitate shift-work in many places where it is not yet accepted. It will increase opportunity by providing more jobs requiring technical or management skills, it will cut out many dull, heavy or fatiguing jobs.

It appears then, that automation offers great and rewarding prospects to the nation as a whole, to management and to the workers. It is, however, likely to develop slowly—too slowly for the general good. Like all major changes it entails risks and could well create serious problems which will have to be solved if we are to avoid the social and economic dislocation which marred the early history of the industrial revolution. This can be done provided there is co-operation between all concerned. Finally, it should be clearly recognised that automation brings the biggest yet challenge to management.

REGIONALISATION: A REVIEW OF PROGRESS

by HAROLD BURKE, Post Chairman of Council : Chairman of the Special Committee on Organisation

THE Institution is now approaching the end of the second year of the Regional structure. In the majority of cases, Regional Officers will have completed their term of office, and in the natural order of things, new Officers are now being elected. It is, therefore, probably a good time to consider how effective this Regional Organisation has been, bearing in mind that the scheme was introduced amid a great deal of opposition and apathy. It was, however, approved by Council and the Annual General Meeting of members in a fully democratic manner.

It is also timely that we should consider the background which existed at the time when this scheme was first under discussion. At a meeting of Council on 27th April, 1950, the Finance and General Purposes Committee were authorised to form a Special Committee with the following Terms of Reference :-

> "To conduct a general survey of the whole organisation of the Institution and make recommendations as to improvements which will enable the Institution the more efficiently to attain its object."

The under-mentioned members, in addition to myself, accepted invitations to join this Committee :-

Major-General K. C. Appleyard, C.B.E. ;
Mr. W. Puckey (now Sir Walter Puckey) ;
Mr. J. Blakiston ;
Mr. E. D. Broome ;
Mr. R. S. Brown ;
Mr. H. Gardiner ;
Mr. J. E. Hill ;
Mr. B. G. L. Jackman ;
Mr. R. W. Mann ;
Mr. A. Oppenheimer ;
Dr. Herbert Schofield, C.B.E. ;
Mr. C. H. T. Williams.

Throughout their deliberations, the Committee had in mind the following objectives :-

1. To raise the status of the Institution and the standards and effectiveness of the profession and the membership.
2. To make the Institution eligible for a Royal Charter.

Some time was spent on preliminary investigation and the Committee held its first meeting on 29th September, 1950, and issued its first Report in October, 1951. During the first year of their deliberations, the Committee met monthly, and in addition, considerable correspondence was conducted throughout the Institution to deal with a large number of items which were on the agenda for discussion, many of which were finally rejected.

In March, 1952, the Report had reached the stage when it was sent back to the Special Committee by Council with comments and proposed amendments, and the whole series of subjects were again examined in the light of experience and the suggestions which had been received from most of the Sections, including the Overseas Branches. Ultimately, the basic principles, as a Final Report, were approved by Council. Instructions were then issued that it was necessary to amend the Articles of Association, and the final revised Report was approved by Council and the Annual General Meeting held on 28th January, 1954, with a view to the whole scheme becoming effective on 1st July, 1954.

It will be seen, therefore, that the discussions on this project at all levels took approximately four years, and at no time can it be seriously considered that hurried decisions were made which might have a detrimental effect on the well-being of the Institution. Apart from a number of detailed recommendations, the main points in the Report can be summarised under the following headings :-

(a) Headquarters Organisation

The Committee were free to investigate every phase of the Institution's organisation and to make a number of important recommendations for improvement.

(b) Regional Organisation

(c) Standing Committees

The Editorial and Papers Committees were set up in place of the existing Technical and Publications Committee.

The Terms of Reference of all Standing Committees were overhauled and brought up to date.

(d) Journal

The new Journal was devised and issued as a result of setting up the Committees referred to in the preceding paragraph, and because of the change in policy in connection with the size, advertising contracts, etc. The whole basis of the Journal was altered with the object of making it a much more vital part of our organisation, with, at the same time, a balanced economy. It can be fairly claimed that this outlook for the future has been more than justified by the results.

(e) Overseas Administration

A new structure of communications was set up which, together with a scheme for the remission of fees to the U.K., were the outstanding features of this particular section.

(f) Regionalisation

It was considered that the Regional structure offered many advantages to the Institution, the first being control of the effective size of the Council. Under the Constitution at that time, setting up new Sections automatically increased the size of the Council, and similarly the growth of existing Sections beyond a certain number of members also increased its size which had grown steadily over the years. In 1940, there were 48 members, and in 1953, this number had increased to 83. Attendance was not good, and an average of 30% to 40% meant that continuity of thought and good management became increasingly difficult. It was proposed that Council representation should be on a Regional basis, which would have the immediate effect of reducing the size to about 48 members. It was thought that it would be possible to select members on a Regional basis who could find time to attend Council Meetings in London.

The second advantage envisaged was that the responsibility for the expansion of the Institution would be largely in the hands of Regional Committees. In this connection, it was considered that local industrialists were more likely to generate sufficient enthusiasm for the growth of the Institution with their local knowledge and they would have more time for development without being involved in Sectional organisation in connection with lectures, meetings, works visits, etc.

It was recommended, however, that each Region should aim at holding one principal function each year in the form of :-

(i) a Paper given by a prominent industrialist, who would be able to find the time to give a Paper at Regional level which certainly could be published and might also qualify for National Paper status ;

(ii) a Works Visit and Conference at high managerial level ;

(iii) a social event of the same order.

The Regional structure was also charged with the responsibility of co-ordinating the work of the Sections. It was considered that many of the larger and more senior Sections could give invaluable assistance to the smaller ones and to the Graduates' Sections within their own areas, the position of which was deplorable at that time.

It appeared to the Special Committee that many Section Committees had developed their own Terms of Reference over the years and that there was a marked difference of opinion between the Sections on their responsibilities to the Graduates' Sections. In this connection, recommendations were made for the introduction of members at Sectional level on the appropriate Graduate and Senior Committees so that close working arrangements could be effected for the benefit of the Institution.

The delegation of the development of the Institution to the Regions involved new ideas on the subject of the financial background, and it was, therefore, recommended that a new scheme should be introduced which would give freedom of action to the Regions within a budget approved by Council, so that the Regional Committee could develop the Institution's Sectional activities according to the parochial needs of the areas involved. Experience has shown that this scheme has worked extremely well, and at a recent Regional Officers' Conference, it was agreed that it should continue on its present basis. In spite of the criticisms which were levelled at it when it was first introduced, it can be said that, by and large, the Institution is operating on a much more economical basis as a result of the guidance given to Sections by the Regional officials. This is largely an answer to many critics of the scheme who considered that the Regional structure was another organisation interposed between the Council and the Sections which was not likely to be very effective and was bound to cost money.

I think it can be quite fairly said that the dissemination of information regarding the Institution's activities from the Council to the Sections, through the Regions, has been much more effective as a result of the introduction of this scheme.

I had the privilege of serving as Chairman of the Special Committee, and it was my task to pilot the scheme through the various stages of Council discussion when I was Chairman of Council. Since retiring from that office, I have had the opportunity of attempting to put the scheme into practice in my capacity of Midland Regional Chairman. I believe that, after making full allowances for a number of difficulties, it has worked extremely well, but I think it is only fair to say that the Midlands are

an ideal area for the Regional structure, comprising five Sections: Birmingham, Coventry, Wolverhampton, Worcester and Shrewsbury, which are compactly situated geographically so that travelling from Section to Section is not a serious matter. Three of the Sections—Birmingham, Coventry and Wolverhampton—have been established for a long time and have had considerable experience in the Institution's activities, but Worcester and Shrewsbury are new Sections, needing a considerable amount of guidance. The help which has been given to them during the first two years of the Regional structure has been invaluable.

There are also three Graduates' Sections in the Midlands Region, and all the Sections, both Senior and Junior, had certain ideas on how best the Institution could be developed. It will be well understood, therefore, that the combination of thoughts which has emerged from the discussions has been invaluable in strengthening the Institution in the Midlands area.

We were fortunate in the organisation of our Annual Lecture Meeting in December, 1955, in Wolverhampton, when Mr. F. G. Woollard, M.B.E., M.I.Mech.E., M.I.Prod.E., M.I.I.A., M.S.A.E., gave a Paper on "Automation", which was a modified version of the one read by him at the Margate Conference. As might be expected from the title of the Paper and the name of the lecturer, the "house was sold out" some time before the date of the meeting, and a most attentive and enthusiastic audience listened to the Paper and subsequent discussion for two-and-a-half hours.

The Midlands Region's Annual Conference and Works Visit took place on 16th May this year, at the Austin Motor Company's factory, by the kind invitation of Sir Leonard Lord and the Directors of the British Motor Corporation, when an opportunity was given to our members to examine at close quarters practical examples of transfer machines, and afterwards to listen to Papers given by three executives of the British Motor Corporation, who have been responsible for the design and development of these machines, and who told us something of their successes and failures and hopes for the future.

Finally, the social event this year was extremely successful, with Mr. P. G. Masefield, M.A., C.I.Mech.E., F.R.Ae.S., F.I.Ae.S., the newly appointed Managing Director of Bristol Aircraft Co. Ltd., and several other prominent industrialists on the list of speakers. It needs courage to go forward with ideas of this kind. Last year, the first Midland Regional Annual Dinner, although successful from the point of view of importance and status of the people present, was very poorly supported, but on the second occasion this year, the position changed and the room was full to capacity.

I believe the Regional structure has made a most useful start, and in its first two years, it has set up a basis of organisation which is now treated with considerable respect by the Sections. Advice is freely sought and a wider range of engineers in the Midlands have come to know each other as a result of working together. We have succeeded, to some extent, in picking out good ideas from certain Sections and passing them on to others, and finally, we have done this without adding to the financial burden of the Institution. I consider we have already proved that, in the Midlands area, Regionalisation can work well and that it has come to stay.

It is recognised, however, that in other Regions, the problems are not quite the same, and distance between Sections can be a stumbling block, but it is well to consider that members of Sections who may find it difficult to travel 30 or 40 miles to a Regional meeting, may believe that this is preferable to having to take a day off four times each year to travel to London. Moreover, members of various Sections can have an opportunity to exchange views with members in their own area, with their local point of view. It is no longer possible to say that the majority of the management of the Institution and the frame-work of its policy are situated in and function from London. I hope that the idea of Regional Organisation will grow with enthusiasm and that in good time members will come to see that it is a pattern which may well be followed by many other professional Institutions and that we are leading the way in this respect. This may be a little premature, but I am convinced that as the Institution grows, so the value of this feature of our organisation will be more appreciated than it is today.

REPORT OF THE MEETING OF COUNCIL

Thursday, 26th April, 1956

THE fourth Council Meeting of the 1955/56 Session was held at 10, Chesterfield Street, London, W.1, on Thursday, 26th April, 1956. The meeting, at which the Chairman of Council, Mr. G. Ronald Pryor, presided, was attended by 31 members and the following were present by invitation:

Mr. W. M. Buchan, Hon. Secretary, Shrewsbury Section.

Mr. T. E. Love, Chairman of Gloucester Section.

Mr. R. St. John Aylieff, Chairman of Luton Graduate Section.

A special welcome was extended to Mr. R. A. P. Misra, Chairman of the Bombay Section.

Before proceeding with the business, Council agreed to suspend the Standing Orders to allow the Jack Finlay Scholarship, recently inaugurated by the Australian Council of the Institution, to be dealt with. The Institution's seal was affixed to the Trust Deeds of the Scholarship Fund, which will be open to young men in Australia who are students of production engineering.

Finance

It was reported that inflation was having a very serious effect on the Institution's economic position. Rising costs of supplies and services; the increased charges for outside printing, paper and stationery; wage increases to keep pace with business houses in the West End of London; and the very heavy additional postage costs which the Institution was now required to meet, meant that the forecast surplus had now changed into a deficit. Council felt that they had, therefore, no alternative but to accept the recommendation of the Finance and General Purposes Committee that the membership be called upon to accept an increase in the rate of subscriptions. (Full details of these increases will be found on page 336 of the May Journal). It was agreed that the proposals should be put forward at an Extraordinary General Meeting of the members on Thursday, 14th June, 1956.

Production Exhibition and Conference — Olympia, May 23 - 31

It was reported that nearly all the space available at Olympia had been let and that the Minister of Labour had consented to open the Exhibition. It only remains for members and their friends to visit Olympia in large numbers to ensure the success of this enterprise.

Conference of University Professors

The Chairman of Council, who had just returned from Delft, gave a resumé of what had taken place at the Conference. He reported that it had been a most worthwhile meeting and had given the opportunity for a useful exchange of ideas on the teaching of Production Engineering at higher levels. Mr. Pryor felt that the British delegates had much to learn from the experience of the European professors and the reports of the Conference would be studied by the Education and Membership Committees.

Higher Technological Education

Sir Walter Puckey, the Institution's representative on The Lord Hives Council, and Chairman of the Board of Engineering Studies, gave a report on the work which had been done towards the establishment of a National Award in Technology. Details of the new qualification, will be published shortly.

Revised Election Procedure

To obviate long delays in notifying candidates of the results of their applications for membership, it was decided that where the recommendations of the Membership Committee and of the Section Committee were in agreement, the applicant be immediately informed of the result without waiting for the approval of Council.

A suggestion was put forward regarding the rules of admission to the Institution, namely, that in some cases candidates might be admitted to Associate Membership without either taking the Institution's examination or submitting a thesis. This motion is to be fully discussed at the July Council meeting.

Rating Assessment

It was reported that the Institution's assessment had been increased from £955 to £2,112 per annum and that an appeal against this had been lodged. A proposal that the Institution should appeal for exemption from the payment of rates under the Scientific Societies Act was discussed and rejected because it was felt that to appeal with any hope of success the Memorandum of Association would need to be changed, thus altering the whole character of the Institution.

Summer School

The Education Committee reported that Mr. J. A. Sargrove had promised to give the first lecture on "The Application of Automation in Industry" and that Mr. T. Burns of the University of Edinburgh, School of Social Studies, had undertaken to give a lecture on "Human Relations and Automation".

The Journal

It was reported by the Editorial Committee that the increased advertising rates would come into effect from September next. It had also been decided to use a thinner and less expensive paper for the editorial content of the Journal which, it was hoped, might enable some slight saving in cost to be made.

The Papers Committee suggested a personal approach should be made to Institution members who were Chairmen or Managing Directors, asking them if they would be willing to sponsor papers from men in their organisations, particularly papers dealing with research and development aspects of production engineering. It was also hoped that Graduate members of the Institution might be encouraged to prepare papers for publication.

Institution Papers

The following report was made :-

The 1955 Sir Alfred Herbert Paper was presented at the Royal Institution on 9th February, 1956, by Dr. N. H. Mackworth of the Applied Psychology Unit of the Medical Research Council, whose subject was: "Work Design and Training for Future Industrial Skills".

The 1955 George Bray Memorial Lecture was presented at the Royal Institution on 7th March, 1956, by Sir Gordon Russell, Director of the Council of Industrial Design. His subject: "Pride in Workmanship: Today's Challenge", gave rise to a most interesting discussion.

The 1956 Viscount Nuffield Paper would be presented at the University of Bristol on 17th October, 1956, when the speaker would be Dr. Grey Walter of the Burden Neurological Institute.

Research

The following reports were made on behalf of the sub-committees of the Research Committee :-

Materials Handling. The Joint Working Group with the Education Committee had made good progress and hoped to produce their report on a Materials Handling Syllabus and Examination very soon.

The Case Study Working Groups had supplied Studies for publication and hoped to be able to continue the series for at least six months.

The Sub-Committee had arranged a Materials Handling film show, followed by discussion, at the Birmingham College of Technology on 27th March, and had also arranged for a Works Visit to A.C. Delco Ltd., Dunstable, in May.

Future activities included a two-day Convention on Materials Handling, possibly at Leamington, during next October.

Materials Utilisation. The new Sub-Committee, under the Chairmanship of Mr. R. N. Marland, had held its first meeting and formulated revised terms of reference. Panels had been set up to deal with each specified field to be investigated and were engaged in preparing specimen case studies and notes for the guidance of Sections of the Institution who had agreed to establish Working Groups to help in these investigations.

Sources of Information. The Directory was now in draft form and the work of revising and editing was going forward.

Control of Quality. A proposal that the Institution should promote a Conference on Control of Quality, was now being discussed by the Research Committee.

Joint Committee with I.C.W.A. A Joint Meeting was held on 27th March, at which the terms of reference were decided upon and future items for research and report were discussed. Two subjects regarding which it was intended to set up sub-committees were: "Electronics and Kindred Modern Developments as Applied to Process Loading" and "The Economics and Effective Use of Shift Working". Three other subjects which would follow were: investment in plant and tooling for small quantity production; alternative production processes; and the effective utilisation of capital in industry.

Standards

The Standards Committee reported that it had continued to pursue the possibility of obtaining further publicity for International Standards, with a view to making them available in draft form in the United Kingdom. The B.S.I. had now agreed to investigate to see what could be done in this direction.

The Committee had completed an investigation on Cutting Tool Nomenclature which showed that there was considerable dissatisfaction with the existing B.S.S. 1866. It had been agreed that the matter should be discussed at the Conference of Standards Engineers in London on 24th May, 1956.

Institution representatives had been appointed to six new B.S.I. Technical Committees. The Institution had also been invited to appoint a representative on a committee set up by the Institution of Mechanical Engineers to produce a Code of Practice for Guarding Machinery.

Hazleton Memorial Library

It was reported that the catalogue was going very well. Half the number printed had been sold and about 300 were out at Sections. There was a reserve of 200 which it was not thought would last very long. The catalogue had been well received and was having a beneficial effect on the use of the Library.

Local Section Reports

The Council received a number of Regional and Local Section Reports, extracts from which appear on page 401 to 406 of this Journal.

Honours

The Council noted with pleasure that H.M. the Queen had conferred the award of O.B.E. on Mr. J. N. Kirby, President of the Australian Council.

Obituary

The Council recorded with deep regret the deaths of the following members:-

Members. G. E. Allin; G. E. Gilfillan; J. W. Walker; Major E. A. Wimberley.

Associate Members. W. R. Boocock; W. R. Ford; F. Henshaw; J. J. Matthews.

Graduate. I. R. Fellows.

Date and Place of Next Meeting

It was agreed that the next meeting of Council should be held at 10, Chesterfield Street, London, W.1, on Thursday, 19th July, 1956.

Presentation of Two Portraits

Council were very pleased to receive from Mr. H. E. Honer, the founder of the Institution, two portraits: one of the first President, Mr. Max Lawrence, and the other of the immediate Past President, Sir Walter Puckey. Members were particularly glad to welcome Mr. Honer since it was through his efforts that the first meeting of the Institution was called in January, 1921. Mr. Honer told Council of the early history of the Institution and spoke of the correspondence and discussions which preceded its foundation.

The Chairman

The meeting ended with a vote of appreciation for Mr. G. Ronald Pryor whose term of office concludes at the end of June. Members of Council expressed their gratitude for the considerable amount of time and energy which Mr. Pryor had spent in the service of the Institution and for his advice and guidance during his Chairmanship. Mr. J. E. Hill, moving the vote of thanks, said that so long as the Institution could produce men of Mr. Pryor's calibre they could have every confidence in the future.

ELECTIONS AND TRANSFERS

26th April, 1956

BIRMINGHAM SECTION

As Members
O. Poppe, F. B. Willmott.
As Graduates
H. K. Mhatre, W. A. Poole.
As Students
F. R. H. Ellis, D. Harrison, W. Jones, C. F. Smith.
Transfers
From Graduates to Associate Members
W. R. Allen, R. H. Dipple, D. F. Maloney, L. Walker.
From Students to Graduates
A. Boyce, D. Keeling, D. J. Lloyd, J. F. Percival, P. R. Wallis, B. Webb.

BOMBAY SECTION

As Member
M. W. Lalchandani.
As Graduate
P. B. Nair.
As Students
A. K. Ghosh, J. S. Talwar.
Transfer
From Graduate to Associate Member
B. J. Stedman.

CALCUTTA SECTION

As Member
L. Maxwell-Holroyd.
As Graduate
M. A. Warraich.
Transfer
From Student to Graduate
K. Ghatak.

CORNWALL SECTION

Transfers
From Associate Member to Member
F. G. Robinson.
From Student to Graduate
J. C. Newcombe.

COVENTRY SECTION

As Graduate
E. C. Marston.
As Student
M. Spira.
Transfers
From Graduates to Associate Members
J. E. Adkins, L. Walmsley.
From Student to Graduate
P. S. Eden.

New Affiliated Firm
C. A. Norgen Ltd.

New Affiliated Representatives
G. H. Grange, R. E. Knight, P. J. Pass.

DERBY SECTION

Transfers
From Associate Member to Member
J. A. Grainger.
From Graduates to Associate Members
T. A. Clarke, I. C. Lawrence.

DUNDEE SECTION

As Student
W. A. McLean.
Transfer
From Associate Member to Member
R. B. Thomson.

EASTERN COUNTIES SECTION

As Student
K. Akbar.
Transfer
From Graduate to Associate Member
N. S. Fisher.

GLASGOW SECTION

As Graduate
W. Mac. G. Cairns.
As Students
J. G. Burrow, J. M. Jackson.
Transfer
From Student to Graduate
L. F. G. Walker.

GLOUCESTER SECTION

As Student
K. G. Sanders.

HALIFAX SECTION

Transfers
From Graduates to Associate Members
M. W. Alderdice, C. W. Overin.
From Student to Graduate
B. Sutcliffe.

LEICESTER SECTION

As Member
I. F. Fisher.
As Graduate
J. H. Leibi.
As Students
M. J. G. Billingham, D. A. Hall, A. A. Hilfi, R. G. A. Kettaneh, S. C. Nwachukwu, K. P. N. Prabhu.
Transfers
From Graduates to Associate Members
R. L. Bamford, B. Hill.
From Students to Graduates
W. J. Parker, A. F. Todd.

LINCOLN SECTION

As Graduate
K. Anwer.
As Student
J. B. Hoyle.
Transfer
From Associate Member to Member
F. Walker.

LONDON SECTION

As Members
Earl Halsbury, W. S. Hollis, A. F. Smith, A. L. Weeks, N. D. S. Williams.
As Associate Members
C. B. Bolton, F. C. McDonald, A. A. Townsend.
As Associate
I. E. S. Butler.
As Graduates
E. B. Gunther, R. A. Hall, J. M. Hawthorn, S. O. Frith, A. B. Merriam, L. B. A. Murray, R. S. Nicholas, D. E. Smith, M. S. Worms.
As Students
C. R. Burrows, J. H. Ede, N. S. Gay, E. J. Major, J. B. Ranson, D. B. Richardson, C. Stratford, L. M. Sharp, K. J. Stevings, K. E. Younge.
Transfers
From Associate Member to Member
A. J. Bullivant.
From Graduates to Associate Members
A. R. Bishop, P. C. Botting, O. S. Brown, J. F. A. Bryen, M. C. Cox, D. R. C. Holmes, R. A. Kean, W. M. Lassally, R. H. Seally, J. C. F. Whicker.
From Students to Graduates
G. Cheater, A. Green, W. S. Kohn, R. A. Judd, D. B. Rolls, D. A. Wilson.

LUTON SECTION

As Associate Member
R. G. O. Stephenson.
As Graduate
D. S. Townsend.
As Student
D. S. Bone.
Transfer
From Graduate to Associate Member
D. W. Birchmore.

MANCHESTER SECTION

As Graduate
E. Hollingworth.
As Students
A. A. Davenport, A. L. Graham-Bryce.
Transfers
From Graduates to Associate Members
J. C. Higson, J. Waddington.
From Student to Graduate
G. N. Walton.

MELBOURNE SECTION

New Affiliated Firm
H. Rowe & Co. Pty. Ltd.

New Affiliated Representatives
M. Linklater, D. A. Bull.

NORTH EASTERN SECTION

As Associate Member
L. Swan.
As Graduate
P. A. Edwards.
Transfers
From Associate Member to Member
H. B. Topham.
From Graduate to Associate Member
N. Guymer.
From Student to Graduate
R. Redpath.

NORTHERN IRELAND SECTION

Transfers
From Graduates to Associate Members
B. Fraser, P. L. McIlwraith.

NORWICH SECTION

As Members
G. S. Howell, S. C. Ward.

NOTTINGHAM SECTION

As Student
R. L. Sunderland.
Transfer
From Associate Member to Member
T. G. H. Middleton.

OXFORD SECTION

As Graduate
A. S. C. Barker.

PETERBOROUGH SECTION

As Associate Member
P. K. Finney.
Transfer
From Graduate to Associate Member
J. Talbot.

PRESTON SECTION

As Graduates
J. Charlesworth, K. E. Mullen.
Transfers
From Graduate to Associate Member
H. Bainbridge.
From Student to Graduate
R. Copeman.

ROCHESTER SECTION

As Students
A. Greig, B. D. Munn.

SHEFFIELD SECTION

As Member
G. E. Robinson.
As Graduates
F. Johnson, D. A. Knight, K. Snowball.
As Student
C. Gough.
Transfer
From Student to Graduate
J. H. Beddard.

SHREWSBURY SECTION

Transfer
From Associate Member to Member
W. M. Buchan.

SOUTHERN SECTION

As Student
J. L. Dillon.

SOUTH AFRICA SECTION

As Associate Member
A. A. V. Ryan.
As Graduate
R. H. Bailey.
Transfer
From Associate Member to Member
G. M. Pratley.

SOUTH ESSEX SECTION

As Associate Member
J. G. Smith.
As Students
A. C. Churchill, P. H. Webster, G. J. Bennett, R. R. Nichols.

SOUTH WALES SECTION

As Graduate
R. Griffiths.
Transfer
From Graduate to Associate Member
G. C. Pitt.

STOKE-ON-TRENT SECTION

As Student
K. I. Archer.
Transfers
From Associate Member to Member
A. G. Hayek.
From Graduates to Associate Members
J. Donelan, T. Proctor.

SYDNEY SECTION

Transfer
From Graduate to Associate Member
E. R. Costa.

WESTERN SECTION

As Graduate
G. R. Witts.
As Student
L. J. Homer.

Transfers
From Graduate to Associate Member
A. A. Jacobsen.
From Students to Graduates
J. D. Bendall, K. D. Marwaha.

WEST WALES SECTION
As Member
A. H. Thomas.

WOLVERHAMPTON SECTION
As Graduates
P. A. Brunner, J. Fletcher.
As Students
A. E. Accad, L. Chadwick, G. W. Holden, T. H. Jenkinson, R. E. Kettle, D. S. G. Parry, K. E. Parkes, B. F. W. Southall.

New Affiliated Firm
Talbot Stead Tube Co. Ltd.

New Affiliated Representatives
P. Grove,
E. W. Fryer,
A. M. Leslie.

Transfers
From Associate Member to Member
A. N. Griffiths.
From Student to Graduate
A. F. Pate.

WORCESTER SECTION
As Graduate
J. D. Rogan.
As Student
A. K. Banerjee.

Transfer
From Graduate to Associate Member
S. H. Hibberts.

YORKSHIRE SECTION
As Graduate
D. Pickles.
As Student
T. Leadbeater.
Transfers
From Graduates to Associate Members
R. S. Cracknell, F. W. Spence, H. Ward.

NO SECTION
As Graduate
M. J. Silver.

REGION AND SECTION QUARTERLY REPORTS

EAST AND WEST RIDINGS REGION

Halifax

Lecture meetings have been well attended, and a paper dealing with "Computer-controlled Machine Tools" given by Mr. H. Ogden in Febraury, aroused considerable interest.

The March meeting was combined with the Regional Meeting and a paper was given by Sir Ewart Smith on the subject of "Management and Britain's Standing in a Technical World". This meeting was an outstanding success, and Committee members entertained Sir Ewart to a dinner party afterwards.

The main social function of the year was the dinner dance, which was well supported, the chief guest being Dr. A. B. Everest, President of the Institute of British Foundrymen. This was a most enjoyable function.

A Graduate prize scheme has been instituted, and an award is to be given annually by members of the Senior Section Committee for the best Graduate Paper submitted each year.

At the request of the Regional Committee, the future of the Graduate Section has been discussed at some length by the Section Committee, which has expressed itself in favour of the continuance of activities along present lines. The recent fall in the number of Graduate members, however, has been noted and attributed to the lack of suitable courses in Production Engineering at the Halifax and Huddersfield Technical Colleges. Students aspiring to Graduate status are, therefore, finding difficulty in fulfilling the current academic requirements.

The Section Committee has decided to take the initiative in this matter and representations have been made to the education authorities concerned with the view to the introduction of appropriate courses in Production Engineering at an early date. The response so far has been encouraging, but the Section Committee intends to persue the matter energetically until satisfactory conclusion is reached.

Sheffield

The Section Committee heard a very interesting report from Mr. H. Stafford, who is a member of the Standards Committee.

After defining the terms of reference of this Committee he gave a concise summary of the problems being discussed, and recommendations already made. The Section Committee welcome these reports from Standing Committee Members and hope they will be continued in the future.

Yorkshire

This period has seen the presentation of very interesting lectures and also the staging of what was considered by all a very successful Annual Dinner by the Yorkshire Section coupled with the East and West Ridings Region. Maj.-Gen. K. C. Appleyard, Past President, Mr. G. R. Pryor, Chairman of Council, and Mr. W. F. S. Woodford, Secretary, represented the Institution. The principal Guests were The Lord Mayor of Leeds, Alderman Sir James Croysdale, and the Vicar of Leeds, the Rev. Canon C. B. Sampson.

The recent opening of the Leeds College of Technology was commented upon by several speakers, and the Yorkshire Section are using every endeavor to improve the liaison between the Leeds College of Technology, local industrial firms and the Institution, to ensure that full use is made of the £200,000 worth of new production machinery which has been installed and will be largely used for implementing the "Sandwich" Course.

The Graduate interest is being cemented by its close association with the Senior Section. Three Graduate members have attended each Committee meeting, and have expressed their appreciation of this invitation, and their interest of the proceedings.

At the Annual General Meeting the following officials were elected for the next session:- Chairman, Mr. H. Crompton; Vice-Chairman, Mr. L. Rigg; Hon. Secretary, Mr. J. L. Townend, Mr. D. H. Turnbull, Mr. L. Rigg, and Mr. C. L. David were re-elected to the Committee.

EASTERN REGION

Eastern Counties

Three lecture meetings were held during the quarter under review, starting with a meeting in January at which three speakers from local firms gave short Papers on: "Factory Electrical Layout and the Production Engineer"; "A Special Tapping Machine"; "Flaw Detection". These Papers were well supported by slides and other illustrations. The February lecture was given by Mr. G. Kemp, who gave a most interesting Paper on "Drop Forging" — well illustrated by slides and examples of forgings. This Paper not only gave a brief history of drop forging, but also a description of plant used and indicating some of the types of forgings which can be produced today.

The March lecture was given by Mr. R. B. Kemball-Cook on "Work Study". His Paper dealt mainly with the use which management can make of Work Study in analysing and improving methods, setting standards and exercising control over labour and the cost of products. The Paper was well received and a lively discussion followed. The Committee members were very pleased with the support given to this meeting — the first organised independently by the Institution in Colchester.

At the Annual General Meeting which preceded this lecture, the Section Officers and Committee Members were elected for the forthcoming year.

The Section Committee have made most of the arrangements for the 1956-57 lecture programme, as well as arranging two visits during the summer and it is also hoped to be able to arrange a Section Social Function later in the year.

MIDLANDS REGION

Birmingham Graduate

Two lecture meetings and two works visits have been held since the New Year, all being well attended.

At the Annual General Meeting held in March, Mr. R. C. Short was elected Chairman for the coming session and Mr. W. E. Hipkiss was elected Secretary for a further year. The Chairman's address on "Some Observations made dur-

ing a recent tour of Western Germany" was given after the Annual General Meeting and was of great interest to Section members. This was followed by a colourful film by the Volkswagen Co.

It is intended to send delegates to the Liverpool Graduate Conference in April and it is hoped that some sound proposals will emerge to benefit members of the Institution.

A "Graduate Conversazione" is to be held at the Birmingham University during September of this year. This event, the first of its kind to be held by a Graduate Section, will be on a Regional basis and will be entitled "Auto-Motion".

Events for a summer outing are being planned including a car rally on similar lines to that held last autumn.

In conjunction with the Senior Section, arrangements for a Graduate Papers Evening in April are well in hand. Every effort is being made to encourage Students and Graduates of the Section to give full length Papers.

Coventry

At a Graduate lecture last October, and as a member of a "Production Panel", Mr. Wyndham Badger, Education Officer of the Institution, made a statement regarding the qualifications necessary for a Graduate Member to become an Associate Member. This statement caused the Coventry Graduates grave concern as it was interpreted to infer that Graduates who were ordinary Planning Engineers or Jig and Tool Draughtsmen, were ineligible for promotion in the Institution. Advice of the Senior Section was therefore sought, and it is felt that the results of enquiries which were made are worth recording for the benefit of other Graduate Sections. It would appear that the interpretation of Mr. Wyndham Badger's statement was basically correct and in conformity with the rules governing the election of Corporate Members, and in particular, Associate Members, but each application is, of course, taken on its merits.

A sincere vote of thanks was accorded to Mr. W. G. Key on his enforced resignation as Secretary of the Coventry Section. He is leaving the Coventry district, having accepted a new position in the South of England. At the same time the Committee's thanks, together with a suitable present, were conveyed to Mrs. Whitney, who for so many years has been the stenographer for the Section.

Coventry Graduate

The first lecture of the 1955/56 Session was entitled "The Trade Union in Engineering Production" and was given by Mr. T. Wylie. At the second meeting Graduate members asked the "Production Panel" of senior Members a number of prepared questions. The Panel consisted of Mr. D. Burgess, as Chairman, two local industrialists, Mr. D. D. Davis and Mr. H. Weston, and also Mr. Wyndham Badger.

The subject of the third meeting was very kindly suggested by a past Senior Section Chairman, Mr. S. J. Harley, who brought along a large number of colour films to illustrate his lecture on "Some Impressions of a Recent World Tour". Interesting films of Australia, Japan, America, etc., accompanied by informal commentary by Mr. Harley himself, gave those attending a very entertaining evening. At the January meeting films of "Practical Milling Methods" and "Transfer Milling" borrowed from Rockwell Machine Tool Co. were shown. The February meeting was on the subject of "Abrasives" and was given by Mr. A. C. Turner, Grad.I.Prod.E.

The Douglas D. Davis Award evening scheduled for March was cancelled because the minimum number of entries was not submitted. The Award will be offered again at a meeting next September. In its place the Annual General Meeting was held at which two colour films were shown on "Special Purpose Machines" and "Transfer Machines".

A evening visit was made to the works of Coventry Gauge and Tool Co. Ltd. Refreshments were provided and the total attendance was 36, there being 13 visitors. In March a day visit to the works of Stewarts and Lloyds Ltd., Bilston, took place.

Wolverhampton

Three lecture meetings have been held in the quarter under review. The January lecture, "Forgings and Pressings in High Strength Aluminium Alloys", by Mr. J. E. Earl, A.M.I.Prod.E., was of a high standard. In February, Mr. K. Purdy gave a lecture on the "Argonaut Welding Process" and illustrated the subject with a film. This lecture was given at Dudley Technical College, and proved very interesting.

The Committee were delighted to have a member of the Section Committee present a Paper on "The Development of the New British System of Limits and Fits" for the March meeting. Mr. H. Lister, A.M.I.Mech.E., A.M.I.E.E., A.M.I.Prod.E., has been connected with the B.S.I. in the formation of the new system and gave a first-class lecture.

The March meeting was preceded by the A.G.M. and the Committee for the following year will be comprised of Mr. G. A. Firkins (Chairman), Mr. R. J. Sury (Hon. Sec.), Messrs. A. J. Aiers, R. Beasley, A. J. Burns, F. W. Farrer, H. Lister, W. J. Marshall, C. L. Old, W. B. Pamment, A. G. Pate, A. S. Sault, P. J. Shipton, J. A. Styles, R. W. Tomkys. Mr. K. Buckley, who was elected at the A.G.M. has since tendered his resignation due to his business commitments necessitating a removal to London.

Wolverhampton Graduate

The activities of the Graduate Section have been very successful. In January a lecture on "Human Relations in Industry" was given by Mr. J. Maslin, A.I.P.M., F.I.I.A., Personnel Director of Accles and Pollock Ltd. It was very well received by the members present and a lively discussion took place.

In January a party of 20 members made a very interesting tour of the process departments of Messrs. Courtaulds Ltd., of Wolverhampton. During February a most interesting Paper was presented by Mr. A. E. Adams, M.I.E.D., on "Further Developments in Centreless Grinding". This was a continuation of a Paper presented by him last year and it was very well illustrated by a number of slides. Members present enjoyed this Paper and a lively discussion followed. In February a party of members made a detailed tour of the Production Departments of Messrs. Villiers Engineering Co. Ltd., Wolverhampton. The visit was arranged by Mr. L. W. Farrer, Joint Managing Director, who is also a member of the Senior Section Committee. An interesting evening was spent by members of the party touring this modern company.

In March a Saturday morning visit was made by 60 members and their ladies by motor coach to Josiah Wedgewood Ltd., Barlaston. A tour was made of most of the Production Departments and Show Rooms, etc. A very interesting time was had by all the party. The 12th Annual General Meeting was held in March and was followed by a Paper on "American Production Methods through Industrial Engineering" presented by Mr. N. A. Hare, J.P., A.M.I.Prod.E. This was a continuation of a Paper presented by him last year.

The Graduate Committee have held their monthly Committee Meetings at which the usual business has been transacted. The 1956-57 lecture and visit programme has been practically completed and it is ready to be placed before the Regional Committee for approval.

The Section strength remains constant and the Graduate Committee are pleased to report that attendances at visits and lectures are above average. The choice of lectures and companies visited still meets with the Section's approval.

NORTH MIDLANDS REGION

Regional Report

The Region is now fully occupied in preparing for its One-Day Conference which is to be held at Peterborough in June. The theme for the Conference will be "Aspects of Automation". Each Section in the Region have been asked to find a suitable speaker with a second speaker to support them. The speakers will deal with textiles, drop forgings and the manufacture of oil engines.

Arrangements have been made for members to bring with them their ladies and they will be entertained by Hotpoint Ltd., for lunch and during the afternoon and early evening whilst the members are in Conference. The Conference will be held in the Town Hall Peterborough, which has been very kindly loaned by the Mayor and Corporation.

The Region is very grateful to Peterborough Section for the arrangements that have already been made for this Conference.

Lincoln

Since the last quarterly report two meetings have been held, one in December, and the second in January, when Mr. Horovitz read a very interesting Paper entitled "Rubber Reduces Maintenance and Improves Working Conditions". For the first time since the Section was formed the February meeting had to be cancelled owing to bad weather conditions, the lecturer on this occasion being unable to make the journey.

The attendance at all the meetings has greatly improved.

Loughborough College Student Section

Two Committee meetings have been held since November last to discuss the Section Programme. It was decided by the Committee to have more Works Visits.

The first Works Visit was arranged in November to F. Perkins Ltd., Peterborough. The visit was of great interest to most of the members and was a grand success. The Section Committee are grateful to Mr. Henson, of F. Perkins Ltd., for the excellent arrangements for the visit.

In January, Dr. E. L. Diamond, M.Sc., M.I.Mech.E., Assistant Technical Director, of B.S.I., delivered a very interesting lecture on "British Standards in Industry".

The visit to PERA in February was supported by approximately sixty members. The visit was of great educational value to most of the members who were specially interested to see Dr. D. F. Galloway's work on Drilling and Deep Extrusion.

Nottingham

In the last quarterly report it was stated that rather unusual subjects had been deliberately chosen for the lectures this session. Apparently this has not found favour with the members as the attendance at meetings has fallen off this year. There is definitely a desire for orthodox production engineering subjects.

The lecture meeting programme closed with the Annual General Meeting held in Nottingham in March. After this, Section activities will be confined to visits to works during the summer months. The Section is looking forward to a One-Day Conference on "Aspects of Automation" to be held in Peterborough in June.

Applications for membership and transfer are still being well received.

Peterborough

The section has the honour to be host to the North Midlands Region at a Conference to be held in Peterborough in June. The theme of the Conference will be "Aspects of Automation".

The Section Committee has again donated a prize of text books and instruments to the best student in Production Engineering Subjects at the Peterborough Technical College. The winner this year is Mr. R. W. Thulbourne. The prize was presented at the Annual Prizegiving by Sir John Benstead in the name of the Peterborough Section of the Institution.

Mr. E. G. Perrett, who has been Hon. Secretary since the formation of the "Proposed Sub-Section" in 1952 is leaving Peterborough to take up a new post in the North of England. The duties of Section Hon. Secretary are being taken over by Mr. N. Holmes, A.M.I.Mech.E., A.M.I.Prod.E., of F. Perkins Ltd., who has been a member of the Section Committee since July, 1955.

NORTH WESTERN REGION

Regional Report

The North Western Regional Dinner held at the Midland Hotel, Manchester in February was a great success. Prof. H. Wright Baker attended as Guest Speaker for Dr. B. V. Bowden, Principal of the Manchester College of Science and Technology, who unfortunately was unable to attend due to illness.

The other Guests were Sir Roy Dobson, Mr. G. R. Pryor and Mr. W. F. S. Woodford. Members were entertained after the dinner by Mr. Graham Adams, a first-class illusionist.

The North Western Regional Committee wish to thank Mr. J. G. McLean and members of the Social Committee, who again successfully organised the Dinner.

Liverpool Graduate

The main concern of the Committee during the past three months has been the organisation of the Graduates Conference. The Liverpool City Council offered the City Public Libraries as a venue for the Conference, and invited delegates to morning coffee and afternoon tea. The help and advice in the Conference arrangements from the Liverpool Senior Committee, Mr. Caselton (Assistant Secretary), and Head Office staff, is sincerely appreciated. The theme of the Conference is "Education and the Production Engineer" and Mr. G. R. Pryor (Chairman of Council), very kindly agreed to "sum-up" the proceedings.

Section activities have included two lectures on "Design" and visits to I.C.I. Metals Division Works at Kirby and to the Port Radar Station at Gladstone Dock. A Regional Dinner was held in Manchester at which several of the Graduate Section members were present.

Co-operation between the Senior and Graduate Sections has continued at a very high level and the Committee recently commented upon the very fine relationship which existed between the two Sections.

Manchester

The fourth lecture meeting of the session held in January was a Paper given by Mr. D. I. MacDonell, Works Manager, Massey-Harris-Ferguson (Mfg.) Ltd., entitled "Production of Agricultural Implements", illustrated by epidiascope.

The Section Committee wish to place on record the appreciation of the past services of Mr. S. Davey, who retires from the Section Committee due to pressure of work, and of Mr. R. N. Stallard, who has taken up a post outside the area.

Manchester Graduate

The lecture programme this year was modelled on the previous year. The September lecture on "The Gas Turbine Locomotive" by Mr. P. F. Stock was of topical interest, and the October lecture on "Surface Finish" by Mr. J. Halling was technical and the discussion stimulated was quite rewarding. This lecture had been given previously to the Liverpool Section.

The November lecture on "Precision Casting" by Mr. R. G. Nicholas was very good and the January lecture on "The Philosophy of Incentives" by Mr. F. B. Trethewey, departed from the usual more technical lectures but was well received.

The Visits programme has been in the hands of Mr. R. A. Jones, and the day visit with the Liverpool Graduate Section on September 3rd, was to the works of Josiah Wedgewood Limited, Stoke. On October 29th, a visit was made to the works of Crossley Motors Limited and the unusual visit to the British Railways School of Signalling on December 13th was most enlightening and interesting.

On February 11th the British Rayon Research Association Laboratories at Wythenshawe were visited, and the next visit will be to the works of Messrs. C. H. Johnson & Sons Ltd., Wythenshawe.

Stoke-on-Trent

Three Committee meetings and the Annual General Meeting were held during the quarter. At the Committee meeting prior to the Annual General Meeting, Mr. R. Petrie said that he did not wish to seek re-election to the Committee, due to his heavy commitments. Tribute to Mr. Petrie's long and valued service to the Institution was expressed by all members of the Committee. The Secretary, Mr. E. Perry, reported to the Committee that he was taking up a position in Tanganyika and would be resigning in the near future. The Chairman said that under the circumstances he regretted having to accept Mr. Perry's resignation. Members joined the Chairman in wishing Mr. Perry success and happiness in his new venture.

At the Annual General Meeting the retiring members were returned *en bloc*. The following members were also

elected to the Committee: Mr. W. R. Bailey, Mr. W. E. Dazeley and Mr. A. G. Hayek.

The Committee are pleased to report the selection of Mr. Averil and Mr. Meadows as delegates to the National Graduate Conference, and wish to express their appreciation to their employers who have agreed to meet the Conference fees and expenses incurred by the delegates.

The members of the Committee and their wives met together for a dinner at the end of March. It is hoped that this venture will be the forerunner of many future social activities within the Section.

Three lecture meetings were held during the quarter. The January meeting was held jointly with the Local Productivity Committee. Mr. J. B. Jay presented his Paper "Automatic Linking Devices". The meeting was highly successful and the Section is pleased to report a record attendance of 150. Due to disastrous weather conditions only 15 members attended the February lecture on "Pneumatic Aids to Production" by W. J. Ford, M.I.Prod.E. Because of the small attendance, Mr. Ford gave his Paper in the form of an informal talk and discussion and this proved a highly enjoyable form of meeting. The Section would like to express its appreciation to Mr. Ford for the way he battled by road from Cardiff on the day of the lecture and then adapted his Paper to suit his small audience.

The third lecture meeting of the quarter was held at the Hanley Town Hall, and because of illness Wing-Commander Laws was unable to present his Paper. The Section is indebted to Mr. A. G. Hayek who at short notice presented a Paper on "Industrial Engineering and the Economic Aspects of Manufacturing Techniques".

NORTHERN REGION

North Eastern

Meetings during the quarter have been well attended and in January Mr. R. B. Neary presented his Paper "Production Engineering in a Large Engineering Establishment". The Paper was very well illustrated with slides showing recent development in the organisation to which Mr. Neary is attached and a very lively discussion followed the lecture.

Owing to inclement weather, the February meeting was not favoured with the normal attendance. The subject chosen for this meeting was "Remote Control and its Possible Application to Automation", a Paper presented by Messrs. J. D. Oates and A. T. Granger. In spite of the technical nature of the Paper a very interesting discussion was provoked.

The Annual Dinner and Dance was held in February and was graced by the company of Major-General K. C. Appleyard, Mr. G. R. Pryor and Mrs. Pryor, Mr. W. F. S. Woodford and Mrs. Woodford. The speakers on this occasion were Mr. H. H. Mullens, B.Sc., M.I.E.E., Major-General K. C. Appleyard, C.B.E., M.I.Mech.E., M.I.Prod.E., The Deputy Lord Mayor, Councillor Mrs. E. F. Davison and the Section Chairman, Mr. F. Baker.

The function was very well attended and in view of the success of this annual function it is hoped that a larger suite will be obtainable for future years. The Chairman is most grateful to the guests who undertook long journeys to favour the Section with their presence.

There has been some competition for seats on the Section Committee and an election has been necessary.

SCOTTISH REGION

Dundee

The membership figures for the Dundee Section appear to be fairly static; as new members come into the area old members leave. During this session five Committee members have regretfully left the district to take up new appointments. According to statistics we can now say "Join the Committee if you wish promotion or a new and better post".

The two lectures held during this quarter were "New Methods of Measuring Productivity with Particular Reference to the Welding Industry" by Mr. A. G. Thomson, and "Electronic Control in Industry" by Mr. E. Heys. Mr. Thomson's lecture dealt with a completely new approach to work measurement in the welding industry and his lecture was obviously the result of much painstaking research in this field. Mr. Heys covered a very wide range in his lecture dealing with the electronic control of machine tools, paper-making machines and mine winders. This lecture dealt with the wider aspect of production engineering and it aroused a lively interest in this area, where many of the above industries are situated.

Attendances at lecture meetings this year has improved but the Committee are still not satisfied with the number of members of the Institution who attend regularly.

SOUTHERN REGION

Oxford

The first lecture meeting of the 1956 Session was held in conjunction with the Oxfordshire Sub-Branch of the Institute of Cost and Works Accountants, when an excellent discourse on "Cost Accounting as an Aid to Efficient Production" was given by Mr. Leonard Frankland, F.C.W.A., A.C.A., A.M.I.I.A. The programme then continued with the theme "Automation", the next three lectures considering in turn the advantages of using electronic, hydraulic or pneumatic devices for sensing and controlling automatic processes.

The January lecture, "Production by Electronics", presented by Mr. E. R. Davies, was an excellent survey ranging from basic principles to the complexities of computor-controlled machine tools.

"The Application of Hydraulic Mechanisms of Automatic Processes" by Mr. I. McNeill, M.A., Assoc.I.Mech.E., and "Pneumatic Circuiting" by Mr. R. C. D. Grant, B.Sc., A.M.I.Mech.E., served to illustrate the extreme versatility and flexibility of these two media of control and operation. During the course of the discussion following these lectures several people found the answer to their own pet problems of control; in fact this series of lectures proved to be most instructive and constructive.

Reading

It has been the desire of the Committee for some time to have a Dinner and as a result the Inaugural Dinner was held in February. The Section were very fortunate that Mr. Harold Burke was able to attend as chief guest. Other principal guests were Mr. W. F. S. Woodford and Mr. F. T. West, Past Chairman of the Southern Region.

A highly successful evening was enjoyed by all and the musical entertainment organised by Committee members Mr. Mott and Mr. Richardson was really excellent. The function was reported in the local press.

The interest shown in the Section activities by the younger members is being encouraged by including several of the most keen on the Committee for the coming session. The Committee have noticed with gratification that lecture attendances this Session have slightly improved.

SOUTH EASTERN REGION

London

During the quarter under review lecture meetings have been held on the following subjects: "Practical Marginal Costing"; "Electronic Control of Machine Tools"; "Milling Versus Broaching"; "Electronic Digital Computors". The lecture on "Electronic Control of Machine Tools" was held at Brighton and was well attended by members residing in that area.

Plans are in hand for the Lecture Programme for the year 1956/57.

A very successful Dinner was held in February at the Connaught Rooms at which 169 members and guests were present.

In the process of dealing with applications for membership the Committee has discussed the advantages to be gained from the use of referees as well as proposers and seconders. Reference to them would provide information on status, etc., which would be of value to the Committee in determining the appropriate grade of membership.

London Graduate

A Sub-Committee has been formed to handle the arrangements for the 1956 Weekend School which is to be held in September. Consideration has also been given to the 1956/57 lecture and visits programme. A Sub-Committee has been formed and the tentative arrangements include eight lectures, and three or four works visits. Of the eight lectures, five will be concerned with processes, two with management, and one will be of general interest.

During the quarter a Works Visit took place to Enfield Rolling Mills, and it was fully attended.

The Committee is pleased to note the interest which has been shown in the lecture entitled " Production Engineering in the Maintenance and Overhaul of Civilian Air Transport ", given recently by Mr. H. Gray, a Graduate member of the Section. Enquiries have been made for copies of this Paper but permission to publish the Paper has not yet been given by Mr. Gray's employers.

Due to previous commitments of Committee members, only the Section Honorary Secretary will be representing the Section at the Graduate Conference to be held at Liverpool in April.

Preparations for the Section's Annual General Meeting have been completed. Due to business reasons and/or transfer to the Senior Section, Committee member Mr. Bull has resigned and Messrs. Barber, Hyland and Johns, the present Section Chairman will be resigning and will be unable to accept re-nomination.

The films selected for the Annual General Meeting have a total running time of 75 minutes and are entitled " Planned for the Purpose " and " Drop Forgings in Alloy Steels ".

South Essex

The Annual General Meeting of the Section took place in March at Chelmsford, and there was an extremely good attendance of members both at the Meeting and at the Film Show afterwards. The main film was " Calder Hall ", an account of the construction of Britain's first Atomic Power Station in Cumberland. This is the film which created a tremendous impression at the International Conference at Geneva last year.

The retiring members of the Committee were re-elected and Mr. P. H. W. Everitt was elected as Chairman in place of Mr. R. Telford who retires after serving for the last two years.

Many useful suggestions were made in regard to future activities of the Section, concerning both lectures and social gatherings and the very successful meeting closed with the Annual Report by Mr. Soul on the Papers Committee and votes of thanks to the Committee and the retiring Chairman.

SOUTH WESTERN REGION

Cornwall

No arrangements were made for a January meeting. From previous experience it was found that while making every effort to select a suitable evening the date chosen invariably clashed with some New Year activity.

In February, the Section held a joint meeting with a special course at the Cornwall Technical College, by kind permission of the Principal, Mr. C. D. Alder, M.I.Prod.E., the lecturer was Mr. Hugh Bartle, Grad.I.Mech.E., and his subject was " The Right Materials in the Right Place ". Mr. Bartle, who is Assistant Metallurgist at Holman Bros. Ltd., answered many interesting questions in the discussion which followed. The arrangements for this meeting were made by the Head of the Engineering Department, of the Cornwall Technical College; Mr. A. Wakeman, M.I Prod.E.; and Messrs. F. A. Cheshire and F. G. Hawke (Cornwall Section Committee).

Arrangements are progressing for next year's " Compressed Air Conference " and it is hoped to attract more interest even than last year.

Gloucester

The winter is closing upon a very successful programme of five lectures and two works visits. Activities have increased by one lecture over previous years and hitherto there had been no works visits.

In February Mr. A. G. Thompson presented his Paper entitled " New Methods of Measuring Productivity with Particular Reference to the Welding Industry ". This lecture was well attended and held jointly with the Gloucester Engineering Society.

The second lecture was held in March when Mr. L. W. Robson presented his Paper " Productivity and Cost Accountancy ". This lecture was held jointly with the Institute of Cost and Works Accountants.

The Annual General Meeting was held at Dowty Equipment Ltd., Cheltenham, in March. It was followed by a film entitled " Powered Flight " loaned by Shell-Mex and B.P. Co. Ltd.

Western Graduate

The present Committee is now near the end of its term of office and reviewing its life it is noted that there have been many changes in its membership. Of the original ten members there are only three (Chairman, Vice-Chairman and Senior Section representative) who have seen the session right through. Four members have joined H.M. Forces, two have left the district and one has resigned. The practice of inviting new members to attend a Committee meeting in order to observe and ask questions regarding the affairs of the Section has proved a most useful method of bringing forward the more enthusiastic ones. Some of the members introduced in this way have since been co-opted on to the Committee bringing its strength up to the total of nine members.

The membership of the Section to date is 142, and this is distributed as follows: Bristol and District 71 ; Gloucester and Cheltenham 24 ; the remaining 47 members being widely spread throughout the Western Section. During the present year the Section has gained 14 new and transferred members whilst losses are only four. Information to hand has shown that at least 15 members in the Bristol District are now in H.M. Forces.

The Committee had arranged four lectures this session in Bristol, three having already taken place. The attendance for two out of three of the lectures was good, but there is a large number of visitors making up this attendance. In the future it is hoped to keep up this number of visitors and increase the number of Students and Graduates.

WELSH REGION

South Wales and Monmouthshire

The Committee are very gratified at the attendance at lecture meetings which have averaged 90 over the present session. It appears that the selection has had universal appeal throughout the Section. In order to still further accommodate the wishes of the members, a circular has been sent to all members requesting information on the subjects in which they are interested and attempts will be made to cover the most popular subjects in next session's lecture programme.

In February, the Regional Committee was honoured by a visit from the Chairman of Council, Mr. G. R. Pryor, and the Secretary, Mr. W. F. S. Woodford. Problems affecting both South Wales and West Wales were frankly discussed and the assistance given by both Mr. Pryor and Mr. Woodford was greatly appreciated. It was felt that this visit will do much to further the interests of the Institution in Wales.

West Wales

The Section Programme of meetings has continued through this quarter marked particularly by the timely and appropriate Papers given by Mr. F. Garner on "Automation" and Mr. J. A. Sargrove on " Electronics ". Following so soon on their success and the impression created at Margate, West Wales was indeed fortunate to secure the attendance of these two authorities. Interest was further stimulated by the well justified press notices.

Association with the activities of local Sections of the Productivity Council indicates a surprising variation in progress. The lively and continued response in some areas makes a startling comparison with the almost complete lack of effect in others.

The West Wales Section has in particular sympathy with the present surge of national concern in the development of technical education. In this connection the closest attention is paid to the facilities and opportunities which are available to future production engineers.

SECTIONS OUTSIDE THE UNITED KINGDOM

Adelaide

One meeting has been held since the last Report. This was a lecture on " Preventative Maintenance " by Mr. John Holden, M.A.(Cantab.), A.M.I.E.(Aust.). The lecture covered the organisation and methods and the results obtained in South Australia's largest factory. Forty-three members and

visitors were present, many of them entering in the discussion which followed the lecture.

The 1956 activities of the Section Committee commenced with a Dinner at the Richmond Hotel and was followed by the first meeting. The Committee are sorry to lose the help of Mr. J. H. Law, M.I.Prod.E., and Mr. F. R. Charlton, M.B.E., M.I.Prod.E., who have relinquished duties on the Committee. Over a long period they have made a worthwhile contribution to the progress of this Section. Messrs. J. D. McLachlan, A.M.I.Prod.E., and J. G. Brookman, A.M.I.Prod.E., have accepted places on the Education and Programme Sub-Committees respectively.

Melbourne

There have been no meeting activities of the Melbourne Section during the last quarter as this is the normal period of recess.

During this time, however, the Committee has met several times and a most interesting programme of lectures and works visits for 1956 has been arranged.

Sydney

The first Committee meeting for 1956 was held in February and the main topic for discussion was a proposed degree course in Industrial Engineering at the Sydney University.

As Sir Leonard Lord was visiting his Company's new factory in Sydney, the Committee were able to meet him at an informal luncheon with the Australian Council President, Mr. James N. Kirby.

The lecture programme commenced in March with a Paper by Mr. A. Denning on " Education for Production at Home and Abroad ". Fifty members and friends attended and a lengthy discussion ensued.

Calcutta

In January a lecture meeting was held at which Mr. S. Bhattacharya, A.M.I.Prod.E., Principal of the Government of India (M.O.L.) Industrial Training Institute, gave an excellent talk on " Craftsmanship Training as an Aid to Production ".

In February, a talk on " The Place of Statistics in Production Engineering " by Mr. D. J. Desmond, M.Sc.(Lond.), F.I.S., M.I.E.E., of the Indian Statistical Institute, aroused considerable interest. The standard of the lecture was high and so was that of the discussion that followed.

In March, a Works Visit to the Radio Factory of Messrs. Philips Electrical Co. (India) Ltd., was arranged for the members residing in the Calcutta area.

Two Section Committee meetings were held during the quarter under review.

Hazleton Memorial Library

ADDITIONS

" Machinery's Screw Thread Handbook." 16th edition—re-arranged and re-written. *Brighton, Machinery Publishing Co.,* 1955. 215 *pages. Diagrams.*

Ministry of Labour and National Service—Factory Dept. **" Safety and Health in Industry."** *London, Sky Press,* 1955. 100 *pages. Illustrated.*

Monday, C. **" Capstan and Turret Lathe Practice."** *Brighton, Machinery Publishing Co.,* 1955 199 *pages. Diagrams.*

National Physical Laboratory, Teddington, Middlesex. **" Precision Electrical Instruments : Proceedings of a Symposium held at the National Physical Laboratory . . . November, 1954.** *London, H.M.S.O.,* 1955. 374 *pages. Illustrated. Diagrams.*

Office Management Association, London,. **" The Scope of Electronic Computers in the Office."** (Papers prepared for the National Conference of the O.M.A., 1955.) *London, the Association,* 1955. 102 *pages. Diagrams.*

Sluckin, W. **" Minds and Machines."** *Harmondsworth, Middlesex, Penguin Books,* 1954. 224 *pages. Diagrams.*

" Oxford Junior Encyclopaedia." Volume VII, Engineering. *London, O.U.P.,* 1955. 495 *pages. Illustrated. Diagrams.*

Roberts, F. and Norries, G. O. **" Electronic Business Machines : A Critical Review."** *Thames Ditton, Surrey, Solarton Electronic Business Machines Ltd.,* 1955. 6 *pages. Illustrated. Diagrams.*

Robiette, A. G. E. **" Electric Melting and Smelting Practice."** *London, Griffin,* 1955. 356 *pages. Illustrated. Diagrams.*

Society of Automotive Engineers, New York. **" SAE Manual of Blast Cleaning."** *New York, the Society,* 1954?. 54 *pages. Illustrated. Diagrams.*

Stanford Research Institute, Stanford, Calif. **" Proceedings of Symposium on Automatic Production of Electronic Equipment."** Sponsored by Stanford Research Institute, and United States Air Force, San Francisco, 1954. *Stanford, Stanford, U.P.,* 1954. 119 *pages. Illustrated. Diagrams.*

Thaler, George J. and Brown, Robert G. **" Servomechanism Analysis."** *London, McGraw-Hill,* 1953. 426 *pages. Diagrams.*

United States of America — Department of Defense. **" Administration Sampling Procedures for Acceptance Inspection."** *Washington, the Department,* 1954. 38 *pages. Diagrams.*

United States of America — Department of Labor — Bueau of Labor Statistics. **" Coal-Burning Space Heaters,"** prepared for the Foreign Operations Administration, Office of Industrial Resources by the Bureau. *London, B.I.M.,* 1954. 110 *pages. Illustrated. Diagrams.* (Case study data on productivity and factory performance.)

United States of America — Office of Technical Services. **" Chromium Electroplating."** A reprint of an Original Document resulting from Government-Sponsored Research. *Washington, the Office,* 195-. 160 *pages. Illustrated. Diagrams.*

American Society of Tool Engineers, Detroit, Michigan. **" Die Design Handbook : A Practical Reference Book on Process Analysis, Product Design, Metal Movements, Materials, and Proved Die Designs for every class of Sheet-metal Press Working."** *New York, McGraw-Hill,* 1955. 933 *pages. Diagrams.*

Barton, H. K. and Barton, L. C. **" Diecasting Die Design."** *Brighton, Machinery Publishing Co.,* 1955. 158 *pages. Illustrated. Diagrams.* (Machinery's Standard Reference Series.)

Birmingham Productivity Association. **" Gaining Skill " :** A Report of an investigation into the training of industrial apprentices in Western Germany. *Birmingham, the Association,* 1955. 57 *pages. Illustrated. Diagrams.*

Brewer, Allen F. **" Basic Lubrication Practice."** *New York, Reinhold,* 1955. 286 *pages. Illustrated. Diagrams.*

Carroll, Phil. **" How Foremen can Control Costs."** *New York, McGraw-Hill,* 1955. 301 *pages. Illustrated. Diagrams.*

NEWS OF MEMBERS.

Mr. W. H. Bowman, Member, Sales Director of T. I. Aluminium Limited, has been appointed to the Board of The Aluminium Wire & Cable Co. Ltd., Port Tennant, Swansea.

Mr. W. Castledine, Member, was recently appointed Lecturer in Management Studies at the North Staffordshire Technical College, Stoke-on-Trent. He is the Corresponding Member of the Shrewsbury Section on the Papers Committee.

Mr. F. Cotton, Member, was recently appointed to the Board of Directors of Coventry Climax Engines Limited of Coventry. Mr. Cotton was a founder-member of the Coventry Graduate Section of the Institution, and serves on the Institution's Coventry Section Committee. He is also a member of the Coventry Engineering Society. Mr. Cotton joined the Company as an office boy in 1925. His first five years were spent, in varying periods, in the Design Office, the Jig and Tool Drawing Office and the Works Departments. In 1931 he decided to concentrate on the Production side and became chief of the Jig and Tool and Planning Departments. Following the November 1940 'blitz', Mr. Cotton was in charge of three dispersal units which were established at Oswestry and was appointed Assistant Works Manager in 1941. He returned to the Coventry Works in 1945 and was promoted to Works Manager in 1949.

Mr. F. Cotton

Mr. W. T. Elson, M.B.E., Member, has now been appointed Works Director of Hammerle AG, at their Swiss Factory, as well as a Director of their associated Sales Company in England, Hammerle (London) Limited.

Mr. H. Peter Jost, Member, has been awarded the Derby Gold Medal of the Liverpool Engineering Society for his Paper on "Oil-Free Steam Cylinder Lubrication". Mr. Jost, who is Managing Director of Centralube, Ltd., serves on the Editorial and Papers Committees of the Institution.

Mr. J. Silver, Member, has been appointed Production Director to Jaguar Cars Limited, Coventry.

Mr. Mark H. Taylor, Member, has, by mutual agreement, relinquished his appointment as Director of Rank Precision Industries Limited, and of Taylor, Taylor & Hobson Ltd. Mr. Taylor has served with Taylor, Taylor & Hobson Ltd., for 32 years, being Managing Director for the past 15 years.

Mr. J. A. Stafford, Member, at present Director and General Manager of Taylor, Taylor & Hobson Ltd., will continue in charge of the Company's operation at Leicester.

Mr. R. J. Bailey, Associate Member, has now taken up a position as Designer - Draughtsman in the Development Division of Martonair Limited, at their Farnham factory.

Mr. L. W. Ballard, Associate Member, has recently taken up a position with the De Havilland Aircraft Company at Christchurch as outside Technical Representative (Tool Control).

Mr. A. E. Baxter, Associate Member, has been appointed as the Institution's representative on the North Bucks. Area Engineering Advisory Committee.

Mr. K. H. Buckley, Associate Member, has now taken up an appointment with D. Napier & Son Limited, as Education Officer.

Mr. M. Clegg, Associate Member, has relinquished his position as Production Engineer with Dawson Brothers Limited, Gomersal, Leeds, to take up an appointment as Works Manager with Platt do Brazil Maquinas Texteis Ltda., Cruzeiro, Estado de Sao Paulo, Brazil.

Mr. G. H. Cornwell, Associate Member, has taken up an appointment with Messrs. Cass & Phillip Limited, Hemel Hempstead, as their Chief Engineer in charge of Design and Development. Mr. Cornwell was previously employed with Process Control Gear Limited, St. Albans, as a Technical Electrical Sales Engineer.

Mr. R. A. Cox, Associate Member, has changed his position from Works Manager of Guest Keen & Nettlefolds (Midlands) Ltd., Hillington, Glasgow, and has been promoted to Works Manager at Thomas Haddon & Stokes Limited, Deritend, Birmingham, where he was for eighteen years prior to being transferred to Glasgow.

Mr. J. J. Dyer, Associate Member, is now permanently residing in England and has taken up an appointment as Development Engineer, Special Purpose Machines Division with The Plessey Company Ltd., of Ilford.

Mr. W. H. Edwards-Smith, Associate Member, has taken up an appointment as Lecturer in Workshop Technology at the Leeds College of Technology. He was the Section Honorary Secretary of the Doncaster Section.

Mr. W. R. Gaudion, Associate Member, has taken up an appointment with Canadian Westinghouse Co. Ltd., Hamilton, Ontario, Canada.

Mr. A. Goodwin, Associate Member, has now taken up an appointment as Technical Assistant to the Development Engineer, at Thos. Firth & John Brown, Ltd., Sheffield.

Mr. A. Hollen, Associate Member, has for personal reasons resigned from the Board of Directors and has left the service of The Lapointe Machine Tool Co. Ltd.

Mr. C. C. Jones, Associate Member, who joined the Company in August, 1945 as Assistant Works Manager has now been appointed as Works Manager of British Typewriters Limited, West Bromwich. Mr. Jones had much to do with the introduction of Production Control, Standard Costing Systems and Time Study into the Company. More recently he has played a large part in the planning of their New Factory at Birmingham Road.

Mr. C. C. Jones

Mr. J. M. Martin, Associate Member, has taken up an appointment as General Manager of Hawley Products Limited, London.

Mr. R. W. McEvoy, Associate Member, is now a Technical Representative for William Jessop & Sons Limited, Sheffield, and has recently been given the responsibility for the Northern Ireland territory. He previously worked in the South Wales territory.

Mr. J. H. McPherson, Associate Member, has recently been appointed Assistant Manager in the Engineering Department of Carron Company, Stirlingshire.

Mr. G. B. Parsons, Associate Member, has taken up a new position as Lecturer at the Huddersfield Training College for Technical Teachers.

Mr. R. E. Patmore, Associate Member, has been appointed Works Manager at F. Francis & Sons, Greenwich.

Mr. H. C. R. Pegler, Associate Member, Chief Designer, Fielding and Platt Ltd., Gloucester, has recently been elected by the Council as the President-Elect of the Gloucestershire Engineering Society.

Mr. E. Perry, Associate Member, has taken up an appointment with Williamson Diamonds in Tanganyika. Mr. Perry was until recently Honorary Secretary of the Stoke-on-Trent Section.

Mr. W. Sidwell, Associate Member, has after many years relinquished his position with Higgs Motors Limited, and has taken up an appointment as General and Works Manager of C. H. Parsons Limited, Birmingham.

Mr. S. Smith, Associate Member, has relinquished his position as an Industrial Consultant with H. H. Fraser & Ass. and has joined Shatterprufe Safety Glass Ltd., as their Production Engineer.

Mr. A. R. Foster, Associate, has now taken up an appointment as a Senior Engineer in the Stress Department of Orenda Engineer Limited, Ontario.

Mr. B. T. Aston, Graduate, is now a Toolroom Manager at Bristol Repetition Company Limited, Bristol.

Mr. E. W. Batchelor, Graduate, has taken up an appointment as a Mechanical Engineer with the Kaiser Aluminium Corporation, Washington, U.S.A.

Mr. R. P. Bull, Graduate, is now a Chief Jig and Tool Draughtsman at A. A. Jones & Shipman Limited, Leicester.

Mr. V. K. Burley, Graduate, has relinquished his position as a Technical Assistant at Rolls-Royce, and is now a Technical Assistant in the Organisation and Methods Branch of the Plant Maintenance Department of the United Kingdom Atomic Energy Authority.

Mr. J. R. Duncan, Graduate, has relinquished his position of Chief Tool Designer at the John Deere Ottumwa Works, Ottumwa, Iowa, U.S.A., to take up an engineering appointment with the Caterpillar Tractor Company of Peoria, Illinois, U.S.A. Mr. Duncan is returning to England to help establish Caterpillar's new factory at Bellshill, Lanarkshire.

Mr. F. S. Gawthorpe, Graduate, has taken up an appointment as Technical Assistant in the Borg & Beck Division of Lockheed Hydraulic Brake Co. Ltd., Leamington Spa.

Mr. F. B. Leak, Graduate, has relinquished his position as Crane and Lift Inspector to Messrs. Herbert Morris Limited, Loughborough, to take up an appointment with Messrs. Walker Bros. (Wigan) Limited, as Assistant Plant Engineer.

Mr. K. McConnell, Graduate, has taken up an appointment of Assistant Works Manager with Messrs. Syd Abrams Limited, Manchester.

Mr. V. H. Mody, Graduate, is now with the Ford Motor Company of Canada at their Windsor manufacturing division, and working in the Production Engineering department of the Machine Shop and Stamping plant.

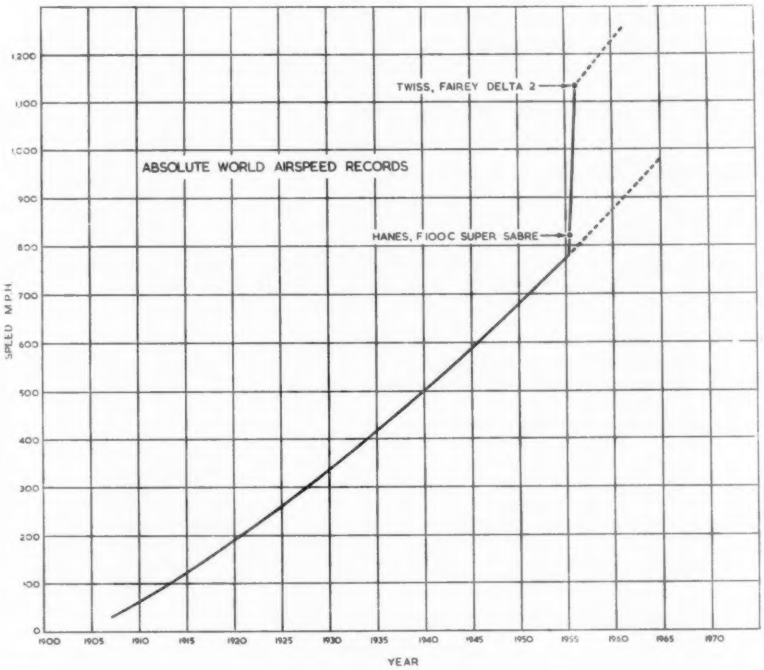
Mr. A. Murray, Graduate, is a Plant Engineer at Thomas Blackburn & Sons Ltd., Preston.

Mr. J. A. Murrell, Graduate, has taken up an appointment as an Experimental Engineer in the Research and Development Department of Mars Limited, Slough.

Mr. S. A. Onions, Graduate, has left the Bristol Aeroplane Company and is a Senior Planning Engineer at Wilmot Breeden Limited, Bridgwater.

CORRESPONDENCE

From: **Mr. R. L. Lickley, Chief Engineer,**
The Fairey Aviation Co. Ltd.,
Hayes, Middlesex.



*See March Journal, page 148

During the discussion following the lecture by Sir Roy Fedden (Britain's Aircraft Needs), I expressed the view that he had put forward much too gloomy a view of the industry, and in particular, was over critical of our technical progress. Apart from his general statements, I was particularly thinking of his paragraph 35.5* As your readers are now no doubt well aware, I was speaking with knowledge of our Delta II, which in regaining the world speed record for Britain, by the largest margin ever recorded (308 m.p.h. or 37%), has shown that it is at least as far advanced in supersonic flying as any American aircraft. The curve shown, shows the major alteration in speed trends which this aircraft has caused.

I cite this merely as one example that the British aircraft industry is not behind the United States in technical excellence, as many more similar advances are of necessity under a security cloak.

Might I also once again emphasize my view that what the aircraft industry needs is more public support for its successes and less public denigration.

"PROBLEMS OF AIRCRAFT PRODUCTION"
University of Southampton, 6th/7th January, 1956

From: **Mr. S. Francis (Member),**
Bleak House Laboratories,
Drighlington, Nr. Bradford, Yorks.

In the Paper by Mr. D. A. Oliver on "Machining Research and Its Impact on Speeding Production",* he said "the original stimulus to develop ceramic tools had been the need for metal economy in view of the shortages at a time when they were wondering whether they would have enough Tungsten and what they would have to do if they had to put Tungsten into other alloys".

The statement as quoted is misleading so, for the benefit of posterity, I will give the facts of the matter. Both the British and American Governments entered into a global war without adequate stores of vital strategic materials especially tungsten, but the fact was not fully appreciated until the cutting of the Burma Road down which came most of the supplies.

Panic legislation, based on incorrect technical advice, resulted in an Order the effect of which would have been to replace tungsten for certain purposes with molybdenum. Fortunately the writer's attention was quickly drawn to this Order and a Minute was written which so effectively exposed the dangers of this step that the Order was negatived in application and the highest possible backing was given to the positive alternative suggestions which including specified economies in the use of tungsten and the development of new hard materials including ceramics.

A Department was created to deal with the suggested economies, and development contracts were placed which enabled work to be commenced on ceramic tools. In a matter of months, the application of the suggested economies was so successful that the acute shortage of tungsten was turned into what the Controller described as "an embarrassing surfeit" and official interest in the development of ceramic tools ceased.

*See April Journal, page 272

The Council of the Institution

1955/56

President
Sir Leonard Lord, K.B.E.

Vice-President
E. W. Hancock, M.B.E.

Chairman of Council
G. R. Pryor

Vice-Chairman of Council
H. G. Gregory

Immediate Past Chairman of Council
H. Burke

Past Presidents
Major-General K. C. Appleyard, C.B.E. Sir George Bailey, C.B.E. Sir Alfred Herbert, K.B.E. Norman Rowbotham, C.B.E. The Rt. Hon. Viscount Nuffield, G.B.E. Sir Walter Puckey J. D. Scaife Dr. H. Schofield, C.B.E. The Rt. Hon. Lord Sempill, A.F.C. Sir Cecil Weir, K.C.M.G., K.B.E., D.L., M.C.

Presidents of Councils outside the United Kingdom
Australian Council—J. N. Kirby
South African Council—H. J. G. Goyns

Chairmen of Regional Committees

East & West Ridings
F. T. Nurrish, M.B.E.
Eastern
E. N. Farrar
Midlands
H. Burke
North Midlands
A. S Johnstone
Northern
F. Baker
North Western
F. W. Cranmer
Northern Ireland
G. H. Moore
Scotland
M. C. Timbury
South Eastern
R. E. Leakey
Southern
T. H. Christy
South Western
C. C. Cornford
Wales
W. Abraham

Additional Representatives on Council

East & West Ridings
J. E. Hill
Midlands
S. J. Harley
North Western
E. G. Eaton
South Eastern
R. Telford

Chairmen of Standing Committees
K. J. Hume B. H. Dyson R. E. Mills R. Ratcliffe M. Seaman The Rt. Hon. Lord Sempill, A.F.C. F. Woodifield.

Elected Members
G. R. Blakely R. S. Brown R. M. Buckle R. S. Clark. A. E. Clifford. Wm. Core H. H. Dawson B. H. Dyson, E. P. Edwards. R. Hutcheson, B. G L. Jackman A. F. Kelley, R. Kirchner E. Levesley R. N. Marland Dr. T. U. Matthew H. Spencer Smith H. Tomlinson.

Co-opted Member
T. Fraser, C.B.E.

Chairmen of Sections outside the United Kingdom where Councils are not established

Bombay
R. A. P. Misra
Canada
G. E. Barkworth
Calcutta
B. F. Goodchild
New Zealand
E. Paton

Overseas Councils

AUSTRALIA

President
J. N. Kirby, O.B.E.

Chairman
J. O. Ogden

Vice-Chairman
C. J. Clark

Elected Members
J. W. H. Clarke R. W. Deutsher S. Downie N. Eaton N. Esserman P. E. Frye W. Gwinnett W. L. Hemer E. J. W Herbert J. H. Law F. W. Penny C. Pullen J. Steer J. E. Strick H. G. Sutton L. W. Worthington

SOUTH AFRICA

President

H. J. G. Goyns

Vice-President

D. S. Clare

Past Presidents

A. B. Anderson R. H. Arbuckle L. H. L. Badham W. G. Gillespie G. Godfrey J. Henry D. Lion-Cachet J. Renwick A. C. Wotherspoon

Elected Members

W. E. Bateman G. T. Chawner D. E. Hamm T. H. Hunter C. J. Mogford D. A. Petrie G. M. Pratley G. G. Tardrew H. H. Waters F. Westall

REGIONAL HONORARY SECRETARIES

East & West Ridings ...	J. L. Townend (Acting)	**Northern Ireland**	W. G. Wyman
Eastern	L. A. Childs	**Scotland**	W. H. Marley
Midlands	B. W. Gould	**South Eastern**	R. Hutcheson
North Midlands	H. Wright	**Southern**	J. W. Taylor
Northern	R. G. Monkhouse	**South Western**	A. Eustace
North Western	J. P. Speakman	**Wales**	J. Bolwell

Secretary of the Institution

W. F. S. Woodford

SECTION CHAIRMEN

C. J. Clark	*Adelaide*	F. Baker	*North Eastern*
T. W. Elkington	*Birmingham*	G. H. Moore	*Northern Ireland*
R. A. P. Misra	*Bombay*	V. Crowther	*Norwich*
B. F. Goodchild	*Calcutta*	L. Shenton	*Nottingham*
C. J. Luby	*Canada*	J. W. G. Pringle	*Oxford*
H. M. Sawyer	*Cornwall*	H. F. Adams	*Peterborough*
W. G. Rootes	*Coventry*	E. G. Eaton	*Preston*
A. Short	*Derby*	T. H. Christy	*Reading*
G. R. Whitehead	*Doncaster*	W. T. Cottingham	*Rochester*
A. Williamson	*Dundee*	E. Levesley	*Sheffield*
F. T. Dyer	*Eastern Counties*	B. G. Williams	*Shrewsbury*
A. Betts Brown	*Edinburgh*	W. G. Gillespie	*South Africa*
M. C. Timbury	*Glasgow*	R. Telford	*South Essex*
T. E. Love	*Gloucester*	W. Abraham	*South Wales*
F. J. Everest	*Halifax*	F. T. West	*Southern*
J. C. Routledge	*Leicester*	H. Porter	*Stoke-on-Trent*
R. S. Hind	*Lincoln*	J. O. Ogden	*Sydney*
J. H. Winskill	*Liverpool*	R. H. Archer	*Tees-Side*
R. E. Leakey	*London*	W. H. Bowman	*West Wales*
R. M. Buckle	*Luton*	C. C. Cornford	*Western*
T. A. Stoddart	*Manchester*	C. L. Old	*Wolverhampton*
C. P. Pullen	*Melbourne*	R. H. Higgs	*Worcester*
E. Paton	*New Zealand*	D. H. Turnbull	*Yorkshire*

GRADUATE SECTION CHAIRMEN

A. C. Turner	*Birmingham Graduate*	J. P. Speakman	*Manchester Graduate*
E. N. Coates	*Coventry Graduate*	P. J. W. Cottrell	*Melbourne Graduate*
M. Alderdice	*Halifax Graduate*	T. Lewins	*North Eastern Graduate*
D. Portman	*Liverpool Graduate*	E. Willcox	*Sheffield Graduate*
F. H. Johns	*London Graduate*	R. Powell	*Western Graduate*
R. St. John Aylieff	*Luton Graduate*	E. Springthorpe	*Wolverhampton Graduate*

SECTION HONORARY SECRETARIES

AUSTRALIA

Adelaide (South Australia) ...	W. L. Hemer, 6 Bedford Street, Brooklyn Park, South Australia.
Melbourne (Victoria, Australia)	R. W. Deutsher, Bank House, 11 Bank Place, Melbourne, C.I., Australia.
Melbourne Graduate (Victoria, Australia)	D. F. McKelvie, J. Gadsen (Aust.) Pty. Ltd., 94 Taylor Street, Clayton, Victoria, Australia.
Sydney (New South Wales) ...	A. Welsh, Room 802, 16 Barrack Street, Sydney, Australia.

CANADA

Canada	P. M. Wood, 7 Tottenham Road, Don Mills, Ontario, Canada.

INDIA

Bombay	E. Fernandes, c/o Burmah Shell, Royal Insurance Bldg., Jamshedi Tata Road, Churchgate, Bombay.
Calcutta	C. K. Haldar, Calcutta Technical School, 110 Surenda Nath Banerjee Road, Calcutta, 13.

NEW ZEALAND

New Zealand	G. Stedman, 3 Harrison Avenue, Belmont, Takapuna, Auckland, N.2, New Zealand.

SOUTH AFRICA

South Africa	The Secretaries, Institution of Production Engineers, Barclays Bank Buildings, Corner Commissioner and Harrison Streets, Johannesburg.

UNITED KINGDOM

Birmingham	B. W. Gould, Dept. of Industrial Administration, College of Technology, Gosta Green, Birmingham, 4.
Cornwall	F. G. Hawke, 17 Church Road, Pool, Redruth, Cornwall.
Coventry (Acting)	A. S. Hopkins, 39 Oaks Road, Kenilworth, Warwickshire.
Derby	P. Warburton, 16 Vicarage Road, Chellaston, Derby.
Doncaster	J. F. Spencer, 236 Warmsworth Road, Doncaster, Yorks.
Dundee	J. Nicolson Low, Technical College, Bell Street, Angus, Scotland.
Eastern Counties	A. B. Brook, Davey, Paxman & Co. Ltd., Britannia Works, Colchester.
Edinburgh	W. Sinclair, Brown Bros. & Co. Ltd., Rosebank Ironworks, Edinburgh, 7.
Glasgow	W. H. Marley, G. & J. Weir Ltd., Cathcart, Glasgow, S.4.
Gloucester & District ...	C. L. Mawhood, 132 Brooklyn Gardens, Cheltenham.
Halifax	F. J. Everest, David Brown Industries Ltd., Park Gear Works, Huddersfield.
Leicester & District	D. G. Swinfield, 65 St. Saviour's Road, Leicester.
Lincoln	H. Wright, 101 Longdales Road, Lincoln.
Liverpool	R. T. Spencer, 44 Kremlin Drive, Stoneycroft, Liverpool 13.
London	R. J. C. Whitaker, The Glacier Metal Co. Ltd., Ealing Road, Alperton, Middlesex.
Luton	J. F. W. Galyer, Engineering Dept., Luton & South Beds. College of Further Education, Park Square, Luton, Beds.
Manchester	J. P. Speakman, 223 Douglas Road, Atherton, Nr. Manchester.
North Eastern	A. C. Foskew, 35 Oakwood Avenue, Low Fell, Gateshead, 9.
Northern Ireland	W. G. Wyman, 'Hopecroft', Glenavy, Co. Antrim.
Norwich	L. A. Tillett, 21 St. Martins Road, Norwich, Norfolk.
Nottingham	C. N. T. Manfull, Chellaston House, Thurgarton Street, Nottingham.
Oxford	E. A. Wootton, 8 Manor Road, Grimsbury, Banbury, Oxon.
Peterborough	N. Holmes, "Arncliffe," 11 Mary Armyn Road, Orton Longueville, Peterborough, Northants.
Preston	R. Thompson, 71 Willows Lane, Accrington, Lancs.
Reading	R. W. H. Mark, 'The Beeches', 41 Reading Road, Woodley, Berks.
Rochester & District	W. G. Clements, 11 Charing Road, Gillingham, Kent.
Sheffield	T. F. Newton, E. Pryor & Sons Ltd., West End Works, Broom Street, Sheffield, 10.
Shrewsbury	W. M. Buchan, Llanberis, 36 Mytton Oak Road, Shrewsbury.
Southern	J. W. Taylor, 44 Deacon Road, Bitterne, Southampton.
South Essex	D. S. Redhead, Marconi's Wireless Telegraph Co. Ltd., Chelmsford, Essex.
South Wales & Mon. ...	J. Bolwell, Creed & Co. Ltd., Treforest Industrial Estate, Pontypridd, Glam.
Stoke-on-Trent	W. R. Bailey, "Riverlyn," Crossfield Avenue, Knypersley, Biddulph, Stoke-on-Trent.
Tees-Side	T. A. Horsley, 24 Clarence Road, Nunthorpe, Nr. Middlesbrough.
Western	A. Eustace, 19 Ferndale Road, Northville, Bristol, 7.
West Wales	H. P. Sanderson, I.C.I. Ltd., Metals Division, Waunarlwydd, Nr. Swansea.
Wolverhampton	R. J. Sury, Widdicombe House, 2 Buttons Farm Road, Penn, Wolverhampton.
Worcester	R. Wheeler, Old Farm House, Parish Hill, Bournheath, Nr. Bromsgrove, Worcester.
Yorkshire	J. L. Townend, 26 Moor Allerton Drive, Street Lane, Leeds, 17.

CORRESPONDING MEMBER IN MIDDLE EAST

J. Merkine, 45 Arlozoroff Street, Ramat-Gan, Israel.

CORRESPONDING MEMBER IN EGYPT

A. F. Abdo, 29 Abo Taleb Street, Terha Bolackia, Shouba, Cairo.

CORRESPONDING MEMBER IN IRAQ

W. G. Rooke, Production Engineer, Iraqi State Railways, Shalchiyah, Baghdad, Iraq.

CORRESPONDING MEMBER IN BRITISH WEST AFRICA

H. P. Halfter, Gold Coast Rlys. & Harbour Admin., P.O. Box 202, Takoradi, Gold Coast, B.W.A.

GRADUATE SECTION HONORARY SECRETARIES

Birmingham	W. E. Hipkiss, 17 Briery Road, Halesowen, Birmingham.
Coventry	D. W. Wright, 14 Haynestone Road, Coundon, Coventry.
Halifax	C. W. Overin, 353 Whitehall Road, Westfield, Wyke, Nr. Bradford, Yorks.
Liverpool	G. L. Smith, 17 Withers Street, Liverpool, 7.
London	R. J. Temple, 59 Brooke Road, Stoke Newington, London, N.16.
Luton	M. J. Hemmett, "Wychwood," Popes Croft, Chandlers Cross, Nr. Rickmansworth, Herts
Manchester	R. C. Yarnell, 1 Demesne Road, Whalley Range, Manchester, 16.
North Eastern	R. Scott, 71 Monk Street, Gateshead, 8, Co. Durham.
Sheffield	G. Shaw, 151 Westwick Crescent, Sheffield, 8.
Western	T. G. Mossman, Y.M.C.A. Hostel, Colston Street, Bristol, 1.
Wolverhampton	W. L. Pace, "Linden" 10 Ezekiel Lane, Short Heath, Willenhall, Staffordshire.
Yorkshire	(Acting) J. L. Townend, 26 Moor Allerton Drive, Street Lane, Leeds 17.

LOUGHBOROUGH COLLEGE STUDENT SECTION

Chairman: A. K. Windeler

Secretary: S. K. Maini, Hazlerigg Hall, Loughborough, Leics.

Old Time Standards

SUNDIAL

The sundial was first brought to Rome about 290 B.C. For long it was the most popular way of measuring time.

Nowadays standards must be authoritative and dependable and are, therefore, derived from the most expert opinion available. In some cases the existing procedure of a producer is accepted as the best practice of the art and is taken as a basis for the standard in question.

Thus British Standard 1004 (Zinc Alloys for Die Casting) was based on the established practice of the Imperial Smelting Corporation in the production of MAZAK.

MAZAK

Foremost by all Modern Standards

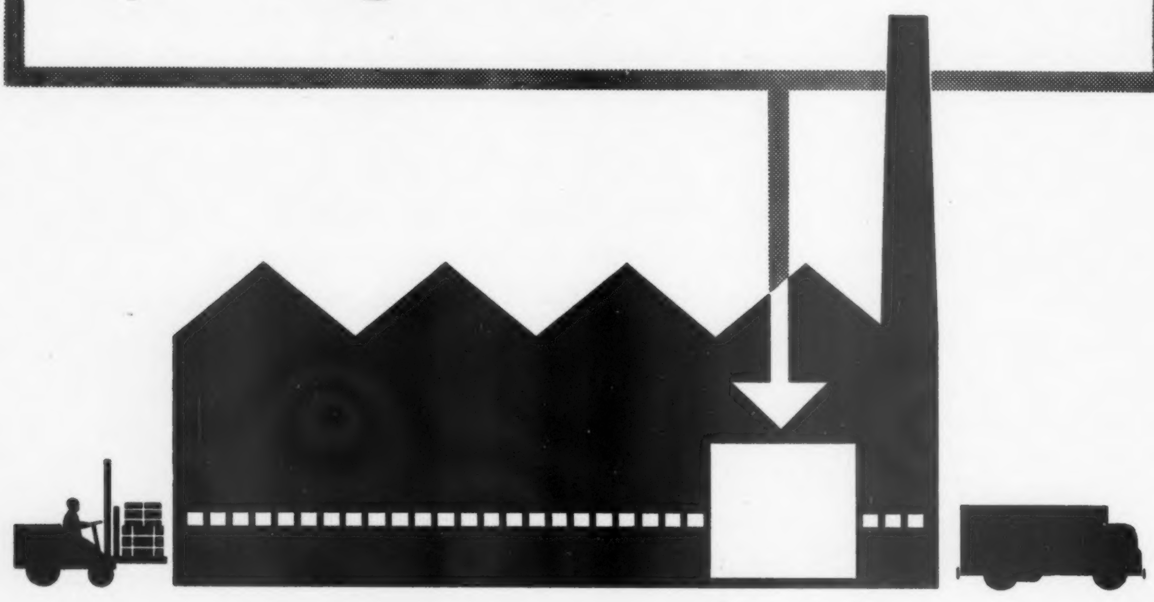
IMPERIAL SMELTING

U.K. MEMBER OF THE CONSOLIDATED ZINC CORPORATION LIMITED

IMPERIAL SMELTING CORPORATION (SALES) LIMITED, 37 DOVER STREET, LONDON, W.1

AUTOMATION OR OTHERWISE

let Wild-Barfield fit heat-treatment into your production line



More and more production engineers are finding that the installation of Wild-Barfield continuous furnaces speeds up production flow and helps to cut costs. By bringing heat-treatment right into the production line, delays and wasteful handling are eliminated. Wild-Barfield make a wide range of continuous furnaces for normalising, hardening, tempering, carbonitriding, bright annealing and other applications. All are built to the highest standards of workmanship to meet the requirements of production engineers and metallurgists. The Wild-Barfield Research Department is available to advise on your heat-treatment problems.

ELECTRIC WILD BARFIELD FURNACES

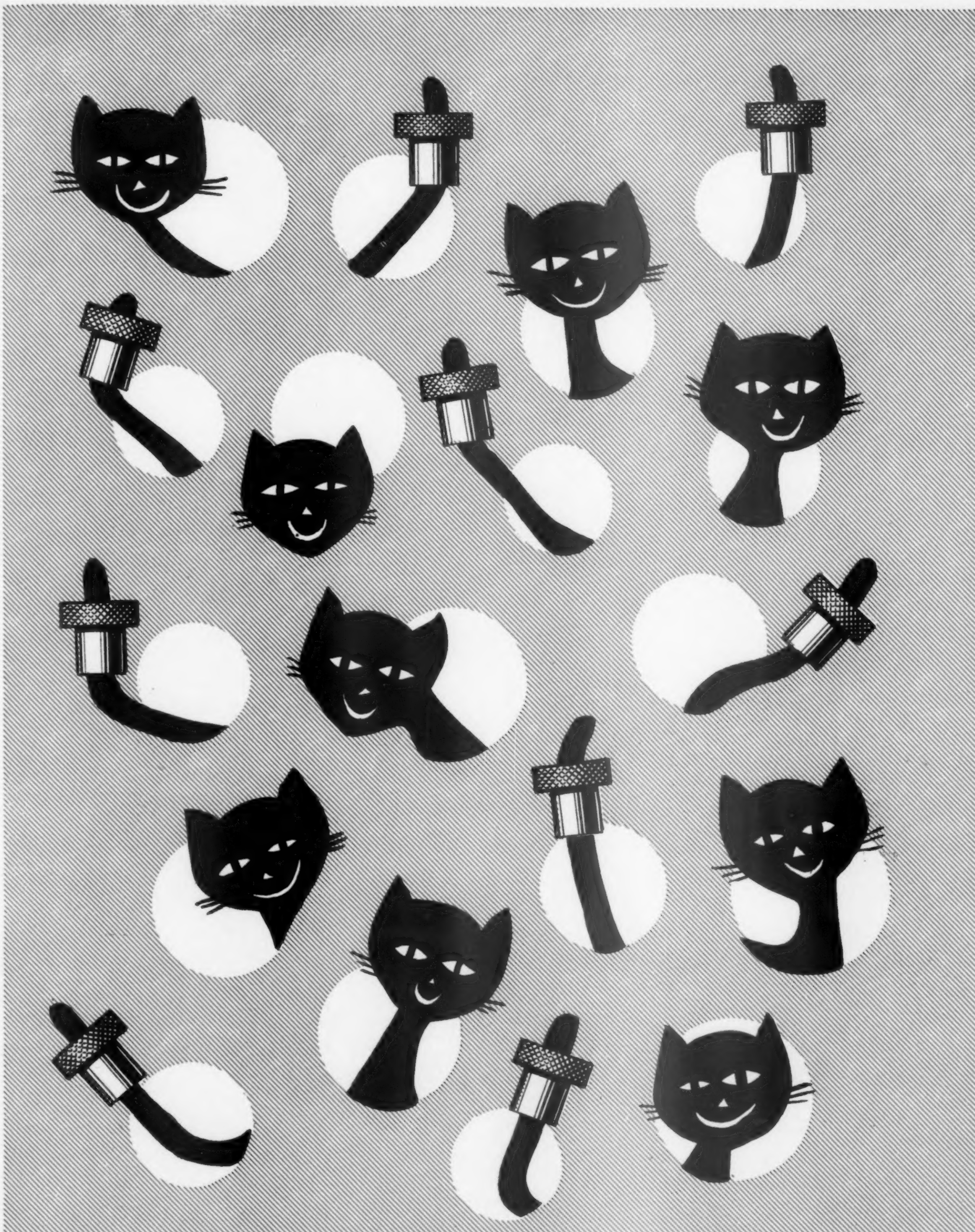
FOR ALL HEAT-TREATMENT PURPOSES

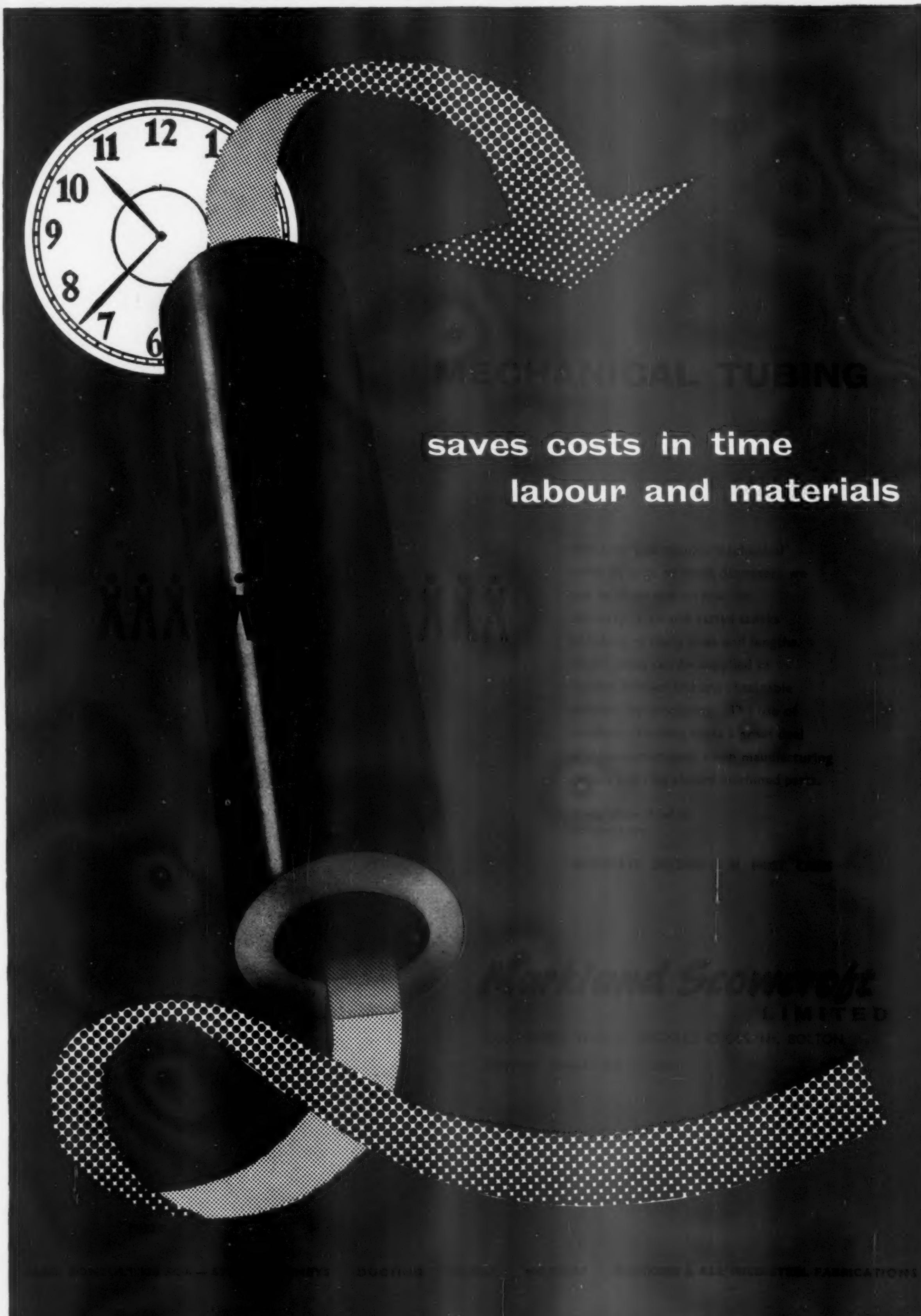
WILD-BARFIELD ELECTRIC FURNACES LIMITED

ELECFURN WORKS, OTTERSPOOL WAY, WATFORD BY-PASS, WATFORD, HERTS. Telephone: Watford 6091 (8 lines)

WB37


from blueprint to complete machine
F. J. EDWARDS Ltd
359–361 EUSTON RD. LONDON N.W.1
BESCO PRODUCTION GUILLOTINE (Mark III)
Very robust, designed for accuracy on high speed mass production, the two larger sizes giving
35 STROKES PER MINUTE
Overcrank, double geared, capacity ¼ in. thick mild steel plates. Open ended, takes plates of unlimited length. Depth of gap 6 in. Single stroke or continuous action. Self-contained motor drive, automatic hold-down, front, back and side gauges. 3 sizes—4 ft., 6 ft. and 8 ft. x ¼ in. thick.
F. J. Edwards Ltd
EDWARDS HOUSE, 359-361 EUSTON RD. LONDON N.W.1.
Telephones : EUSTON 4681 (7 lines) 3771 (4 lines)
Telegrams : Bescotools Norwest London
LANSDOWNE HOUSE, 41 WATER ST. BIRMINGHAM 3.
Telephones : CENTRAL 7606-7
Telegrams : Bescotools Birmingham 3
STAND No 214 EMPIRE HALL
Ground Floor




MECHANICAL TUBING
saves costs in time
labour and materials
LIMITED

'Aloxite' polishing grains & powders

Regd. trade mark

Mirror finishes are produced with ALOXITE *grains and powders in minimum time*

for fast results & beautiful finish

Uniformity of size and shape of grain is the secret of successful metal polishing. ALOXITE aluminium oxide abrasive grains and powders are produced under very closely controlled conditions, to ensure uniformity. An excess of fine particles would slow production. Coarse particles cause deep scratches and spoil the finish.

Practical experience has shown that set-up wheels prepared with ALOXITE abrasive are far superior to wheels made with other manufactured grains, or with emery. Consistently satisfactory results, faster production, and longer wheel life, can be relied on with ALOXITE polishing grains and powders. There are two qualities: "TP" for general work and "TPX" for polishing stainless steel, only.

INTERNATIONAL MACHINE TOOL EXHIBITION 1956
June 22 - July 6, Olympia, London. Stand 308 Grand Hall Gallery

CONSISTENT RESULTS · FAST RESULTS · FINEST FINISHES
WITH **ALOXITE** POLISHING GRAINS AND POWDERS

Abrasive Products by CARBORUNDUM

THE CARBORUNDUM C^O. L^TD. MANCHESTER

THE CARBORUNDUM COMPANY LIMITED, TRAFFORD PARK, MANCHESTER, 17 PHONE: TRAFFORD PARK 2381

INTERNATIONAL MACHINE TOOL EXHIBITION 1956

Selson MACHINE TOOLS

OLYMPIA JUNE 22-JULY 6

on stand No.

46

CLEVELAND
Model AB $1\frac{5}{8}''$ capacity Single Spindle Dialmatic
Spindle capacity—maximum round bar ... ... $1\frac{5}{8}''$
Spindle speeds infinite—ranging from 40-3200 r.p.m.

GAUTHIER
Model GM.12 Precision Automatic
Largest diameter of component, round ... ... $\frac{1}{8}''$
Maximum length of component ... ... 6″
Model W.1 Precision Gear Hobbing Machine
Maximum gear diameter ... ... $2\frac{1}{2}''$

HILGERS
Model HDY.114 Semi-Automatic Cold Tube Bending Machine
For tubes up to $4\frac{1}{2}''$ o.d. x $\frac{3}{16}''$ wall thickness
Model HYB. 70 Automatic Cold Tube Bending Machine
For tubes up to $2\frac{3}{4}''$ o.d. x $\frac{5}{64}''$ wall thickness

KOLLMANN
Model VF.5 Vertical Milling Machine, Solid Bed Type
Working surface of table ... ... 71″ x 25″
18 spindle speeds ... ... 20-1000 r.p.m.
Model EMAV.62 Openside Plano Milling Machine
Working surface of table ... ... 106″ x 35″
Power milling length ... ... 98″

MALCUS
Model MC-5 Centreless Grinding Machine
Largest diameter ground ... ... 6″

MOREY
Extra Heavy Duty Vertical Aeroframe Profiler and Milling Machine
Working surface of table ... ... 48″ x 120″
Distance between columns ... ... 60″

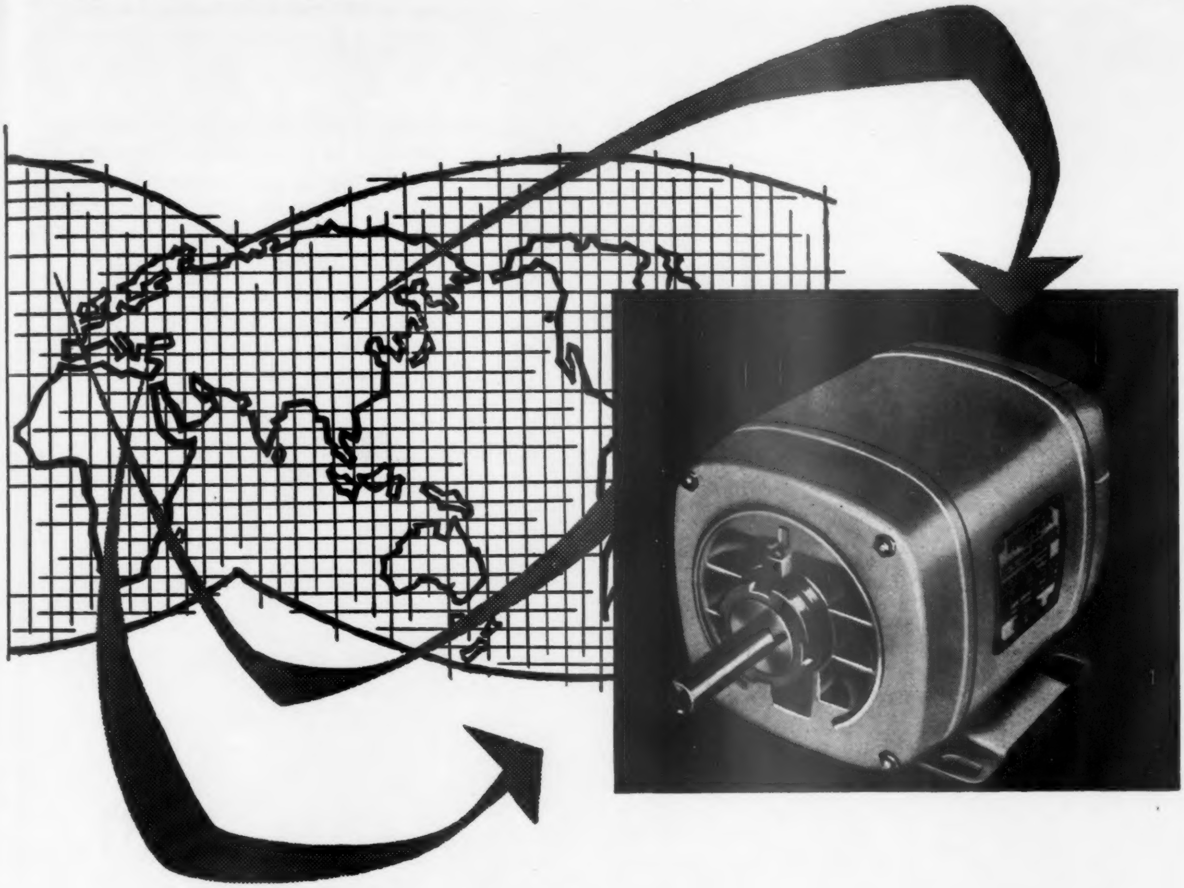
OLIVER
No. 2 Arc Face Mill Grinding Machine
Capacity ... ... 4″-24″ Face Mills

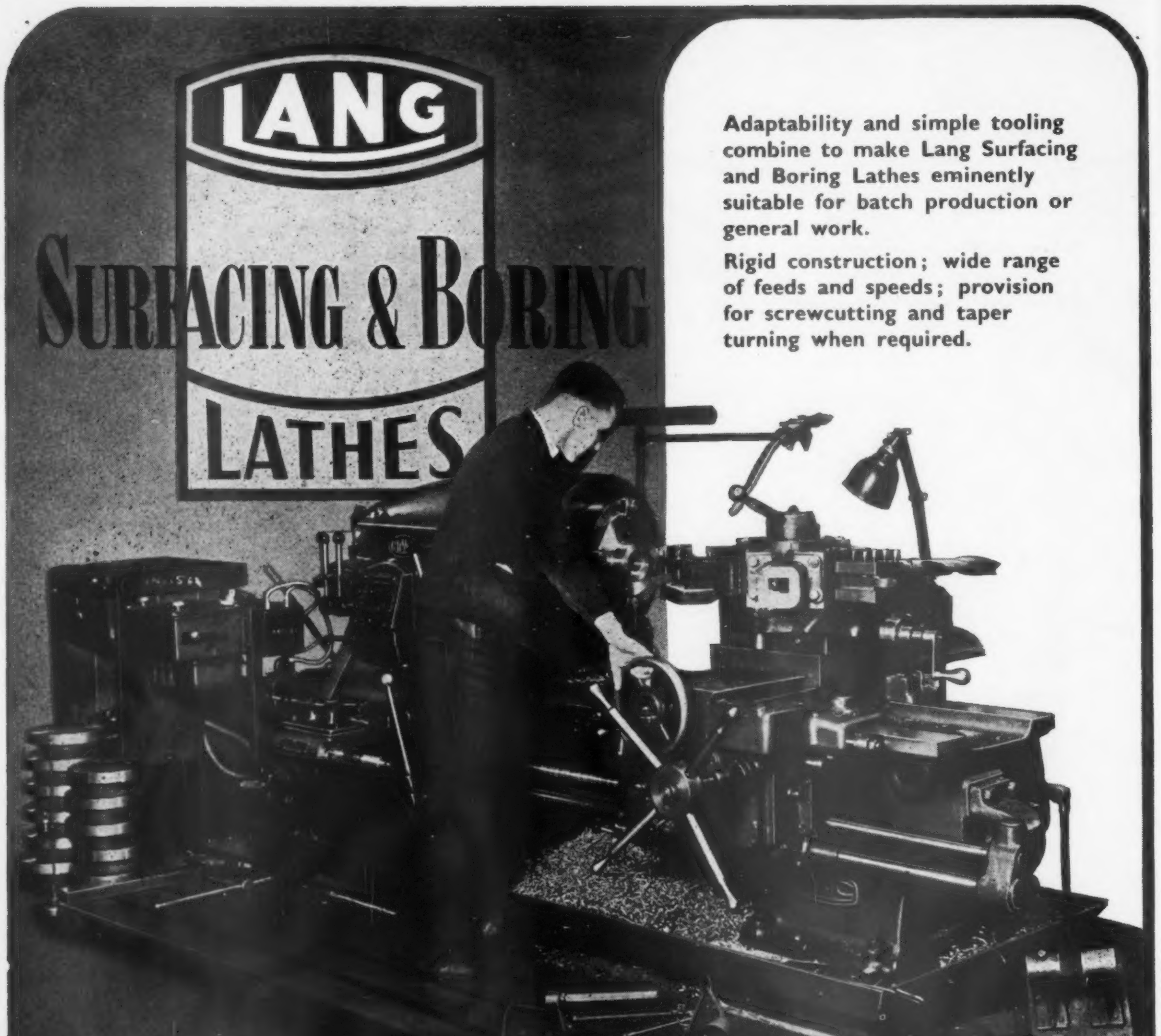
PRAHOMA
Model LW. Heavy Duty Surface Grinding Machine
Working surface of table ... ... 60″ x $19\frac{3}{4}''$
Model L.12 High Production Precision Surface Grinding Machine
Working surface of table ... ... 51″ x $13\frac{3}{4}''$
Model RS.7 High Production Precision Surface Grinding Machine with Circular Rotary Table
Diameter of magnetic chuck ... ... $27\frac{1}{2}''$

SOMUA
Model Z.1 Horizontal Milling Machine
Working surface of table ... ... $47\frac{1}{4}''$ x $11\frac{3}{4}''$
12 spindle speeds:
Horizontal spindle ... ... 50-2500 r.p.m.
Vertical spindle ... ... 40-2000 r.p.m.
Model Z.3 Horizontal Milling Machine
Working surface of table ... ... 64″ x $14\frac{1}{2}''$
12 spindle speeds ... ... 40-2000 r.p.m.

STUHLMANN
Model NZ. 250 Internal Keyseating Machine
Maximum stroke... ... ... 10″
Groove width ... ... $\frac{1}{8}''$ - $1\frac{1}{4}''$

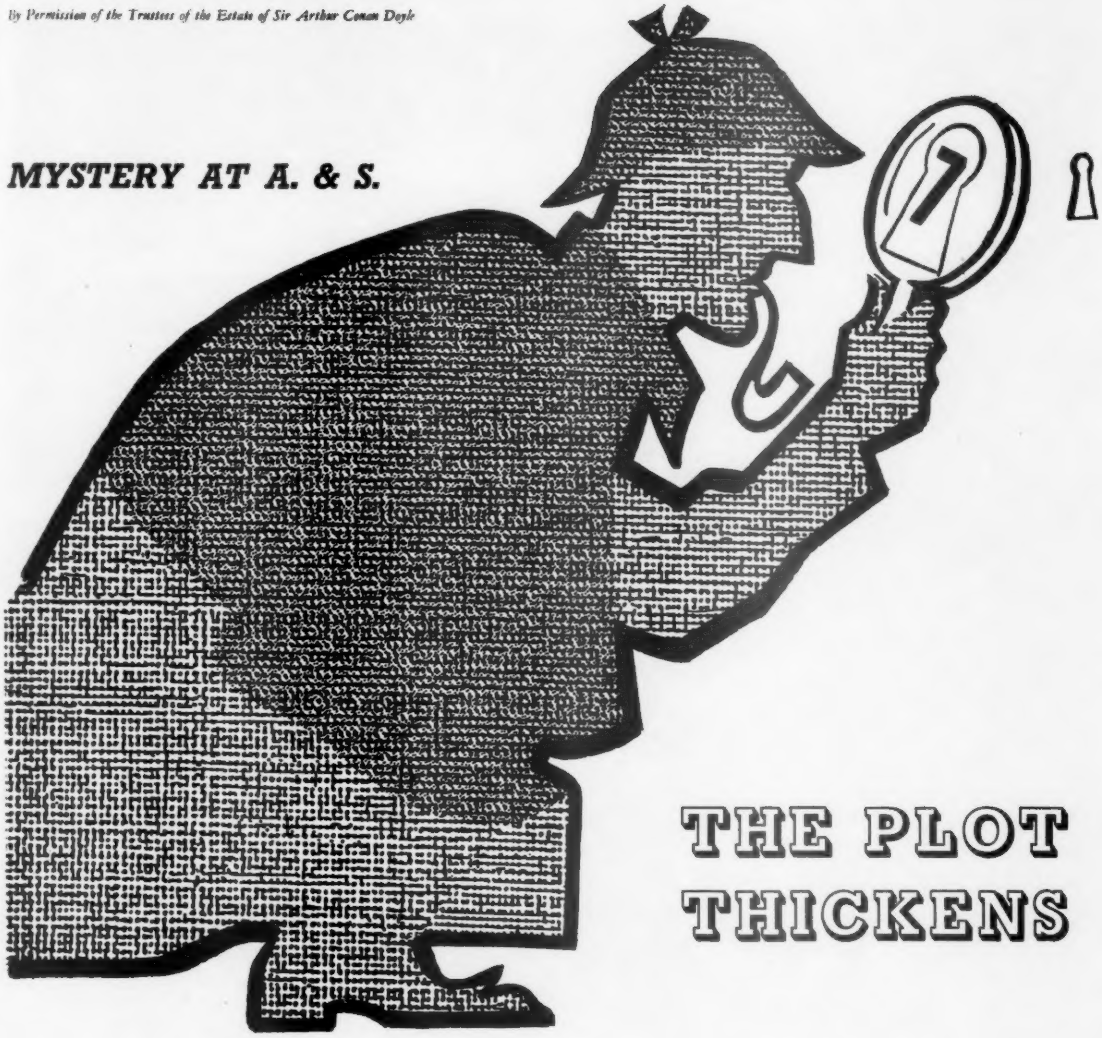
TROJAN
Universal Oil Grooving Machine
Maximum length of groove cut ... ... 7″
Maximum diameter of work admitted over saddle... 8″




LANG
SURFACING & BORING
LATHES
Adaptability and simple tooling combine to make Lang Surfacing and Boring Lathes eminently suitable for batch production or general work.
Rigid construction; wide range of feeds and speeds; provision for screwcutting and taper turning when required.
JOHN LANG & SONS LTD.
JOHNSTONE NEAR GLASGOW
Phone JOHNSTONE 400

By Permission of the Trustees of the Estate of Sir Arthur Conan Doyle

MYSTERY AT A. & S.



THE PLOT THICKENS

What is behind all the secrecy at Adcock & Shipley?

Why is the figure '7' so often referred to?

What are these new machines and developments

that the experts in milling machines have promised **us?**

The answers to these questions will be of great importance to anyone interested in milling machines.

The PLACE to remember is **STAND 216 · EMPIRE HALL · OLYMPIA**
The OCCASION, **INTERNATIONAL MACHINE TOOL EXHIBITION**
The DATE, **JUNE 22nd—JULY 6th INCLUSIVE!**

ADCOCK AND SHIPLEY LTD
P.O. BOX 22 · ASH STREET · LEICESTER
Telephone: Leicester 65154-6 Telegrams & Cables: Adcock, Leicester


There are bars and bars...


Versatile
—Powerful
— for heavy duty on a wide range of work.
Archdale
34″ VERTICAL
REVERSIBLE AUTOMATIC FEEDS AND QUICK POWER TRAVERSE IN THREE DIRECTIONS
The characteristic power and rigidity of the 34″ Vertical Milling Machine is demonstrated to good effect when taking a ¼″ cut at 3½″ per minute on this 4% carbon steel billet. This machine is installed at Geo. Swift & Sons Ltd., who find its great versatility invaluable in producing a wide range of machine tool components. All 12 feeds and spindle speeds are selected from the front of the machine, the speeds ranging from 29 - 520 or 36 - 638 R.P.M., and the feeds, ¾″ to 20″ per minute.
JAMES ARCHDALE & CO., LTD.
BIRMINGHAM 16 · SOLE SELLING AGENTS : ALFRED HERBERT LTD. COVENTRY

Immediate delivery from local stock

IN YOUR DISTRICT OUR APPOINTED STOCKIST OFFERS IMMEDIATE DELIVERY OF MOTORS

- BATH. Stanley Engineering Co.
- BELFAST. Hendron Bros. (Belfast) Ltd.
- BIRMINGHAM. Electric Plant Installations (Birmingham) Ltd.
- BRISTOL. R. R. Britton, Hanham.
- BROMLEY, KENT. Simmons Electrical Winding Co. Ltd.
- CAMBRIDGE. Electric Wiring & Repair Co.
- CARLISLE. G. Bowman Ltd.
- COLCHESTER. E. H. Ruddock Ltd.
- COVENTRY. G. R. Marson Ltd.
- DUBLIN, EIRE. Kelly & Shiel Ltd.
- DUNDEE. Lowdon Bros. & Co. (Eng.) Ltd.
- DUNSTABLE. B. Thomas.
- EDINBURGH. Archibald Turner.
- EVESHAM. Booth & Bomford Ltd.
- GLASGOW. John S. Young & Co. Ltd.
- GRANTHAM. Grantham Electrical & Eng. Co. Ltd.
- HALIFAX. W. Warburton & Co.
- HOVE, SUSSEX. Armature Service Co. Ltd.
- HUDDERSFIELD. Hainsworth Laycock Ltd.
- HULL. W. A. Kirkby & Co.
- LEICESTER. H. C. Pretty & Son Ltd.
- LIVERPOOL. Sandon Motor & Eng. Co. Ltd.
- LONDON. J. H. Hayman Ltd.
- LONDON. W. Steward & Co. Ltd.
- MAIDSTONE. Drake & Fletcher Ltd.
- MANCHESTER. E. Lee & Co.
- MANSFIELD. E. W. Hawley Ltd.
- NELSON, LANCASHIRE. Nelson Engineering Co. Ltd.
- NEWCASTLE-UPON-TYNE. Eckford & Geesin Ltd.
- NEWPORT, MON. Brand Electrical Engineering Co. Ltd.
- PAISLEY. James Kilpatrick & Sons Ltd.
- PLYMOUTH. J. W. Davis, (Plymouth) Ltd.
- PORTSMOUTH. Harbottle-Leeson Ltd.
- RUSHDEN, NORTHANTS. Cyril Norris & Son Ltd.
- SHEFFIELD. Vector Electrical Co. Ltd.
- SOUTHAMPTON. L. Kittow & Sons Ltd.
- TAUNTON. Jarvis & Evered Ltd.
- UXBRIDGE, MIDDLESEX. Bignell & New Ltd.
- WARRINGTON. W. A. Boulting Ltd.
- WOLVERHAMPTON. C. A. & W. J. Postings Ltd.

'ENGLISH ELECTRIC'

industrial motors

THE ENGLISH ELECTRIC COMPANY LIMITED, QUEENS HOUSE, KINGSWAY, LONDON. W.C.2.

Industrial Motor Works, Bradford

WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

DM.50D6

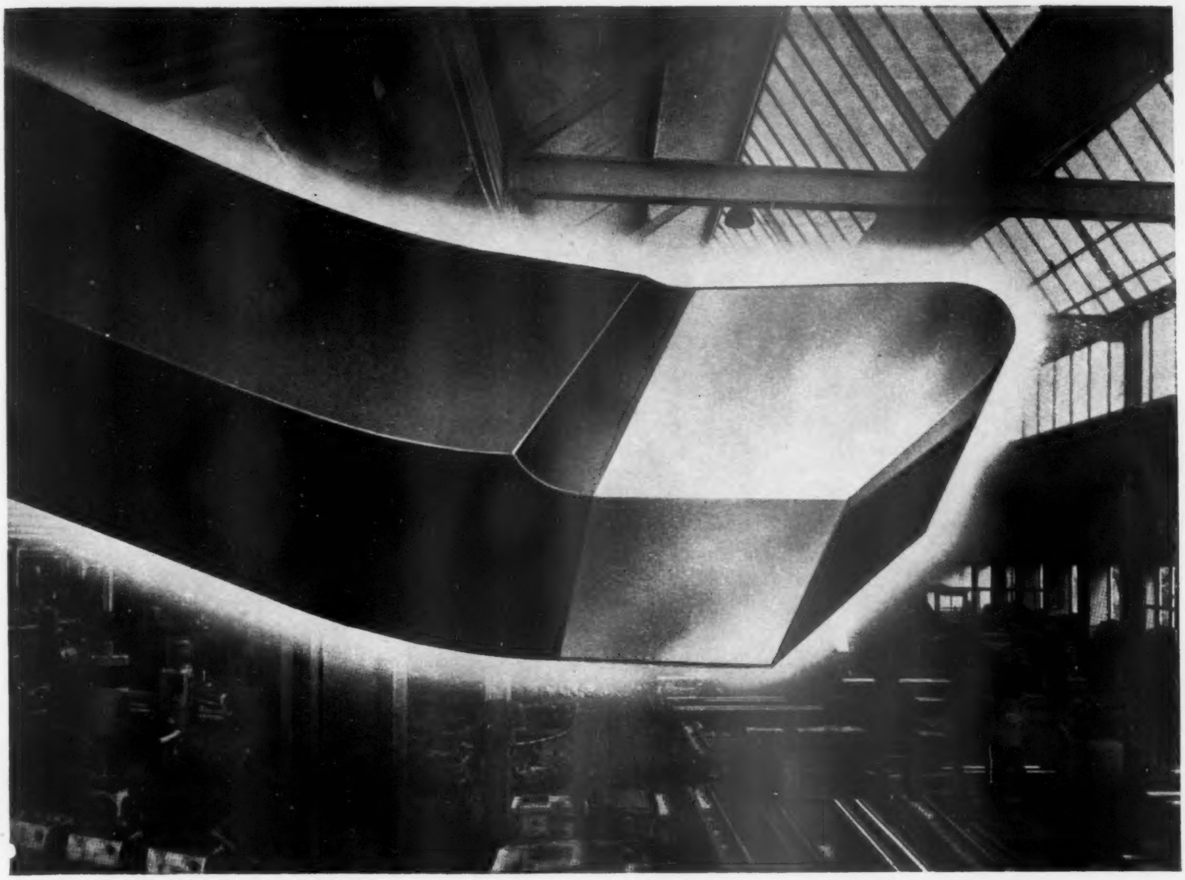
CTB nozzles outlast them all

Glostics Ltd

AGENTS · **IMPREGNATED DIAMOND PRODUCTS LTD**

TUFFLEY CRESCENT · GLOUCESTER

A $\frac{1}{16}''$ bore Carbon Tetra Boride Nozzle with tapered lead-in after four months use with alumina shot.
Note:—The bore at the nozzle throat is only $\frac{1}{32}''$ larger than when new.



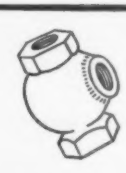

Streamlined
SERVICE

how to get rid of these headaches in your plant

Simply install Lang Pneumatic Control Equipment. It has widely variable application based on standard components to all kinds of machinery; it effects precision control over complex sequence operations; it enables the utmost use to be made of unskilled labour; and it is constructed of non-corrodible parts which give long life under heavy, continuous duties.

Manually controlled production machinery inevitably results in rejects which reflect human error and inefficient times—no matter how good the operator.

Over 700 leading industrial concerns in this country are using Lang Pneumatic Control Equipment on a wide variety of precision machinery and industrial functions.



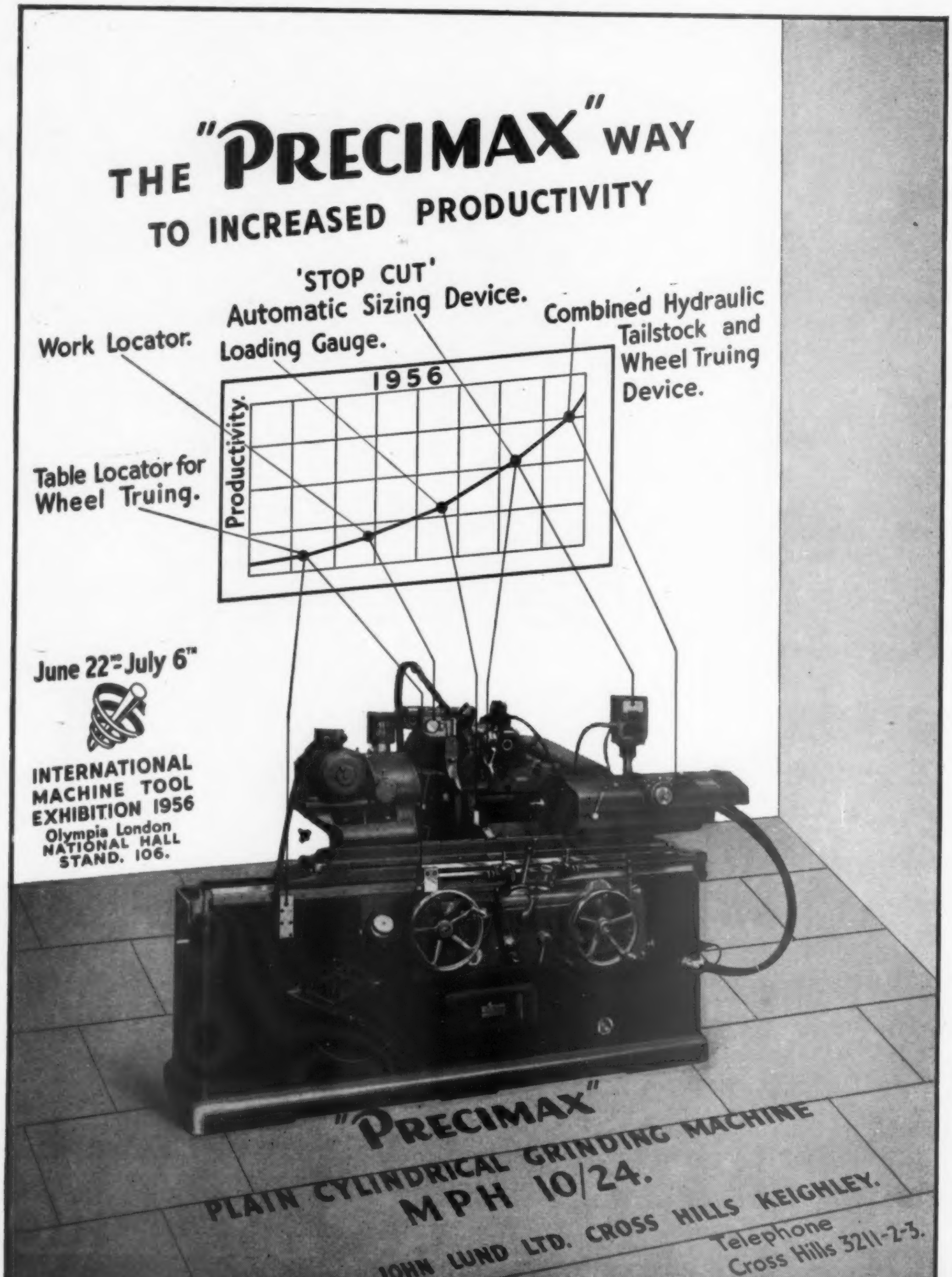
35 stop valves of this type were produced under Lang control against 10 under the former manual operation.

LANG PNEUMATIC CONTROL EQUIPMENT entirely non-corrodible

Plan with

LANG PNEUMATIC LTD

VICTORY WORKS BIRMINGHAM ROAD WOLVERHAMPTON Tel: 25221·2·3


THE "PRECIMAX" WAY
TO INCREASED PRODUCTIVITY
'STOP CUT'
Automatic Sizing Device.
Work Locator.
Loading Gauge.
Combined Hydraulic
Tailstock and
Wheel Truing
Device.
1956
Productivity.
Table Locator for
Wheel Truing.
June 22nd–July 6th
INTERNATIONAL
MACHINE TOOL
EXHIBITION 1956
Olympia London
NATIONAL HALL
STAND. 106.
"PRECIMAX"
PLAIN CYLINDRICAL GRINDING MACHINE
MPH 10/24.
JOHN LUND LTD. CROSS HILLS KEIGHLEY.
Telephone
Cross Hills 3211-2-3.


KG
MACHINE TOOLS
E.M.O. Instrumentation Ltd. employ Keighley 'K.S.E.' Internal Grinders for the production of high precision ball race components.
A completely self-contained and compact machine, the 'K.S.E.' is designed for high speed, accurate grinding of bores from $\frac{3}{16}$" to $1\frac{5}{8}$".
please address enquiries to:
NEWALL GROUP SALES LIMITED
PETERBOROUGH PHONE: PETERBOROUGH 3227-8-9 KEIGHLEY PHONE: KEIGHLEY 4294
A 60,000 R.P.M. electrically driven high speed grinding spindle producing 5 MM. bores at the Bracknell factory of
E.M.O. INSTRUMENTATION LTD.

A MACHINE OFFERING GREAT ADVANTAGES FOR ECONOMICAL SPUR AND HELICAL GEAR PRODUCTION AND WIDE VERSATILITY WITHIN ITS WORKING RANGE

the KOEPFER WUM 52

Fully automatic gear hobbing machine

	Semi-Automatic cycle without magazine feed	Fully Automatic cycle with magazine feed
MAXIMUM PITCH D.P.	10	10
MAXIMUM DIA.	$5\frac{1}{8}$"	1"
LONGEST FACE	6"	$4\frac{3}{8}$"

Features

Fully Automatic operation by using magazine feed. Operator can supervise several machines at once. Time taken for chucking work-piece only 5 secs. against 20-60 secs. for hand chucking.

Semi-Automatic cycle operation in cases where magazine feed cannot be applied, reduces time and number of hand operations.

Readily accessible Switch Panel and Push-button Controls permitting quick preselection of various functions such as normal, climb, plunge cut longitudinal hobbing and automatic cycle or combinations of these are factors reducing setting-up time to minimum.

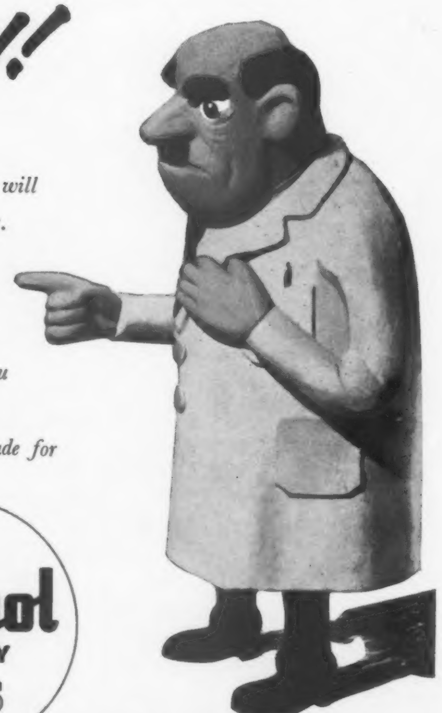
9 different hob speeds, from 104 to 980 r.p.m.

9 different longitudinal or plunge feeds, from .002" to .063".

This is one of the machines on show at our Stand No 625 at The Machine Tool Exhibition

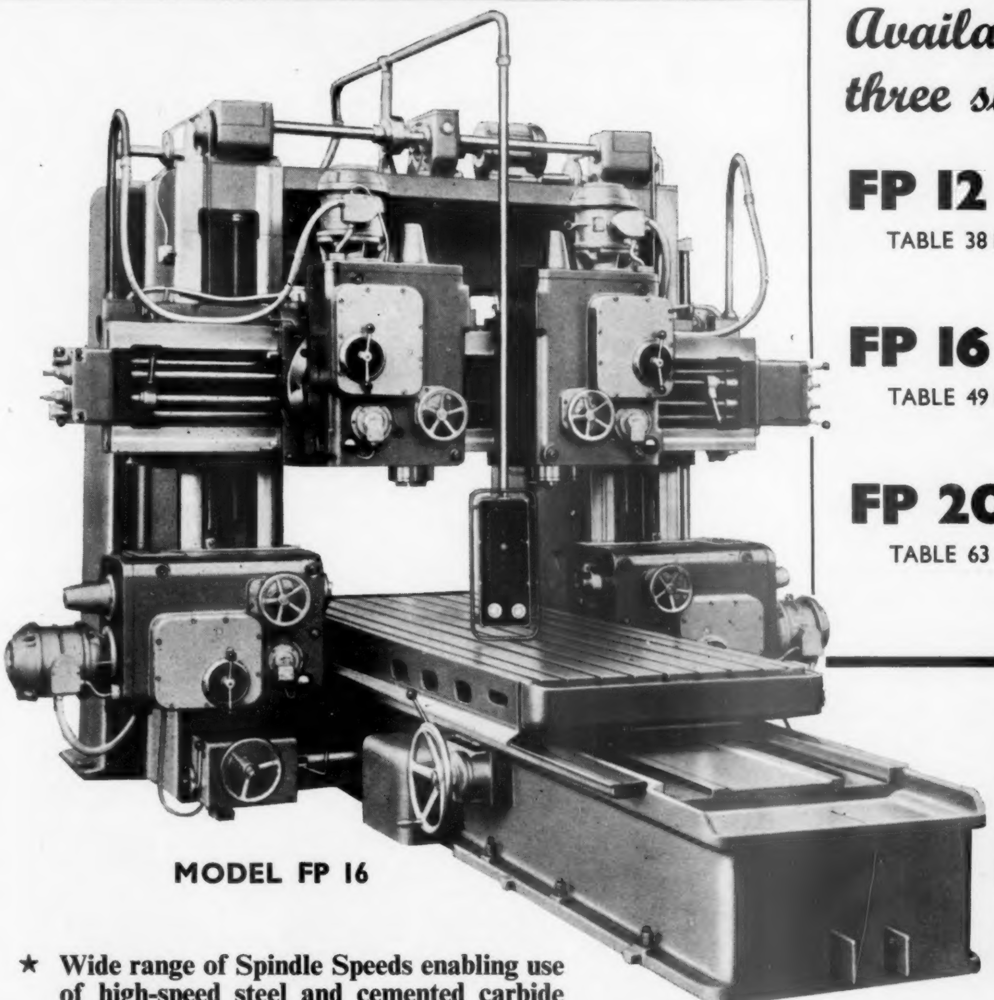
FOR FULL DETAILS WRITE FOR PUBLICATION NO. KF.3 TO SOLE AGENTS: **SIDNEY JONES**

SIDNEY G. JONES LTD. 8 BALHAM HILL, LONDON, S.W.12. BATtersea 3246 Telex No. 8723



ZBROJOVKA

Plano Millers



MODEL FP 16

Available in three sizes

FP 12
TABLE 38 in. by 118 in.

FP 16
TABLE 49 in. by 140 in.

FP 20.
TABLE 63 in. by 157 in.

International Machine Tool Exhibition
June 22—July 6, 1956, Olympia, London, Grand Hall, Stand Nos. 45 & 61

- ★ **Wide range of Spindle Speeds enabling use of high-speed steel and cemented carbide tipped cutters.**
- ★ **Table speeds infinitely variable.**
- ★ **Independent drive to individual headstocks, individual drive to table and headstock feeds.**
- ★ **Automatic clamping of cross rail to guide-ways.**

Model FP 16 is available for inspection

Sole Selling Agents

Our showrooms are only a few minutes from London Airport

EMT **ELGAR** *Machine Tool Company Limited*
HAMPTON ROAD WEST · HANWORTH · FELTHAM · MIDDLESEX
Phone: **FELTHAM 4266.** Cables & Grams: **SHIPMENTS, FELTHAM**


HOLES BY
THE DOZEN...

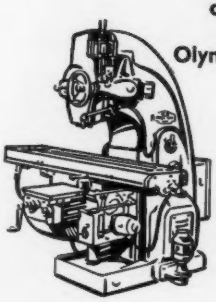

FROM STOCK...
Crofts
"RADIATION" WORM REDUCTION GEARS
...FRACTIONAL UP TO 450 H.P.
STANDARD "R" TYPE
UNIVERSAL MOUNTING TYPE
STANDARD "R" TYPE GEARS FROM STOCK up to 65 H.P.
Ratios 5-1 up to 60-1
Larger Units up to 450 H.P. early delivery.
UNIVERSAL MOUNTING TYPE STOCK UNITS up to 2½H.P.
Ratios 5-1 up to 60-1
Standard, vertical and inverted. Adaptable for every mounting position.
Crofts RADIATION Worm Reduction Gears
CROFTS ENGINEERS LTD
WRITE FOR CATALOGUE 152/43
Crofts (ENGINEERS) LIMITED. BRADFORD 3. ENGLAND
PHONE: 65251 (15 LINES) GRAMS:—"CROFTERS BRADFORD"

dependability...

VISIT STANDS 204 EMPIRE HALL & 401 NATIONAL HALL

INTERNATIONAL MACHINE TOOL EXHIBITION OLYMPIA

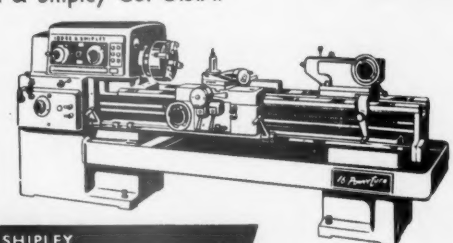
A selection from our range of machine tools which will be exhibited at Olympia—Stands 204 & 401



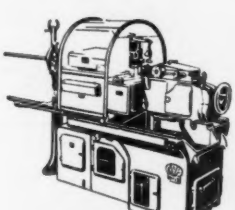
CVA KEARNEY & TRECKER
KNEE TYPE MILLING MACHINES

From 3 to 30 H.P. including the new TF "Twin Feature" machine

Range of toolmakers' lathes now manufactured under licence by C.V.A. from the Lodge & Shipley Co. U.S.A.

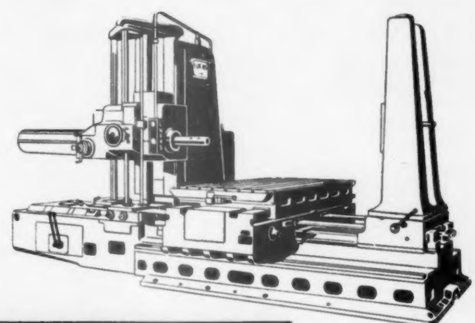


LODGE & SHIPLEY "Powerturn" LATHE



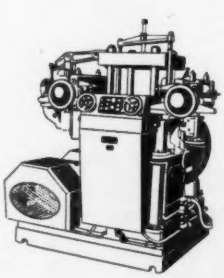
CVA
SINGLE SPINDLE AUTOMATICS

New range from ½" to 1⅝" capacity



LUCAS HORIZONTAL BORER

Modern series of precision horizontal boring machines

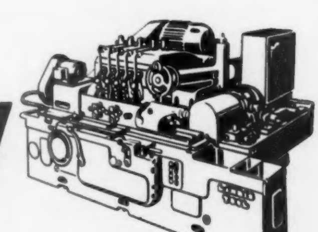


CVA
HIGH SPEED DIEING PRESSES

Four models from 10 to 50 tons including the new High Speed 25 ton machine

LANDIS & GARDNER GRINDERS

The most complete range of grinding machines



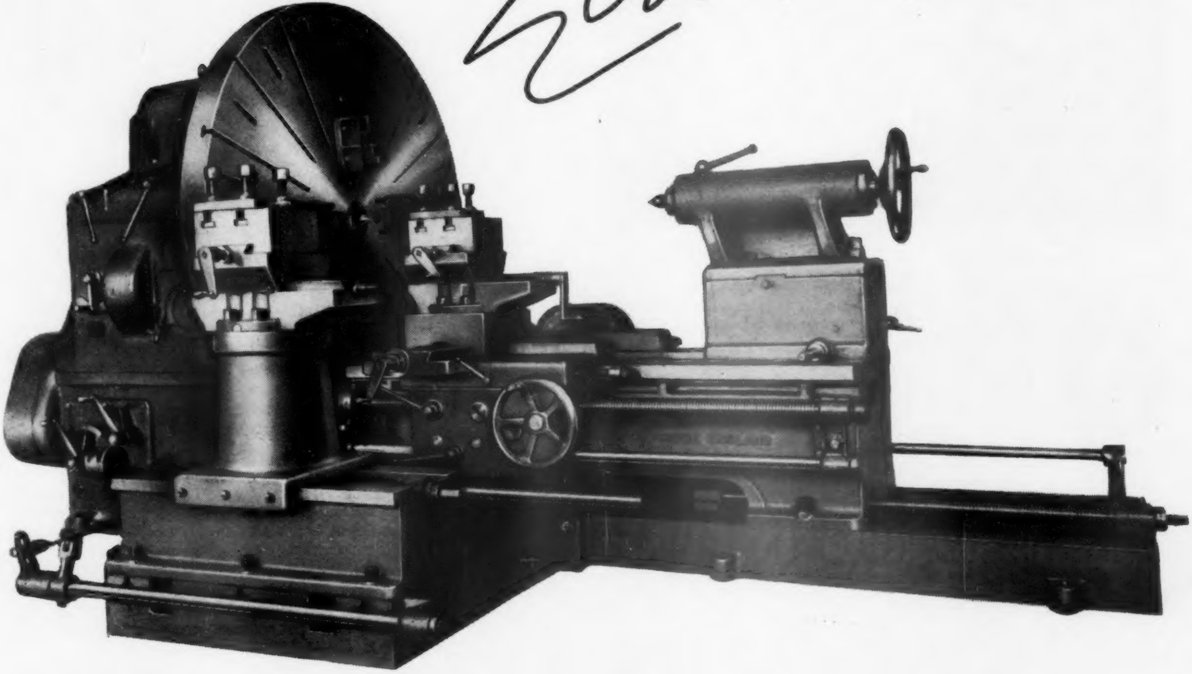
E.H. JONES (MACHINE TOOLS) LTD

GARANTOOLS HOUSE
PORTLAND ROAD, HOVE, SUSSEX
Telephone: HOVE 47253 Telegrams: Garantools, Portslade

LONDON · BIRMINGHAM · EDINBURGH · MANCHESTER · BRISTOL

Rainbow

BROADBENT *Lathes*



21" Break Lathe

A machine designed for turning large and awkwardly shaped workpieces. The sliding bed allows work up to 7 ft. 6 in. diameter and 4 ft. long to be swung in the gap and turned on the outside by tools mounted on the auxiliary bed. This type of machine can be fitted with a pit in front of the headstock to increase the turned diameter to 11 ft. Similar machines can be supplied with capacity to suit individual requirements.

See this and other examples of the fine range of BROADBENT MACHINES ON STANDS 36 & 504 at the International Machine Tool Exhibition.

BROADBENT

HENRY BROADBENT LIMITED

SOWERBY BRIDGE, YORKS *Telephone:* HALIFAX 81331

but nothing compares with

Eclipse

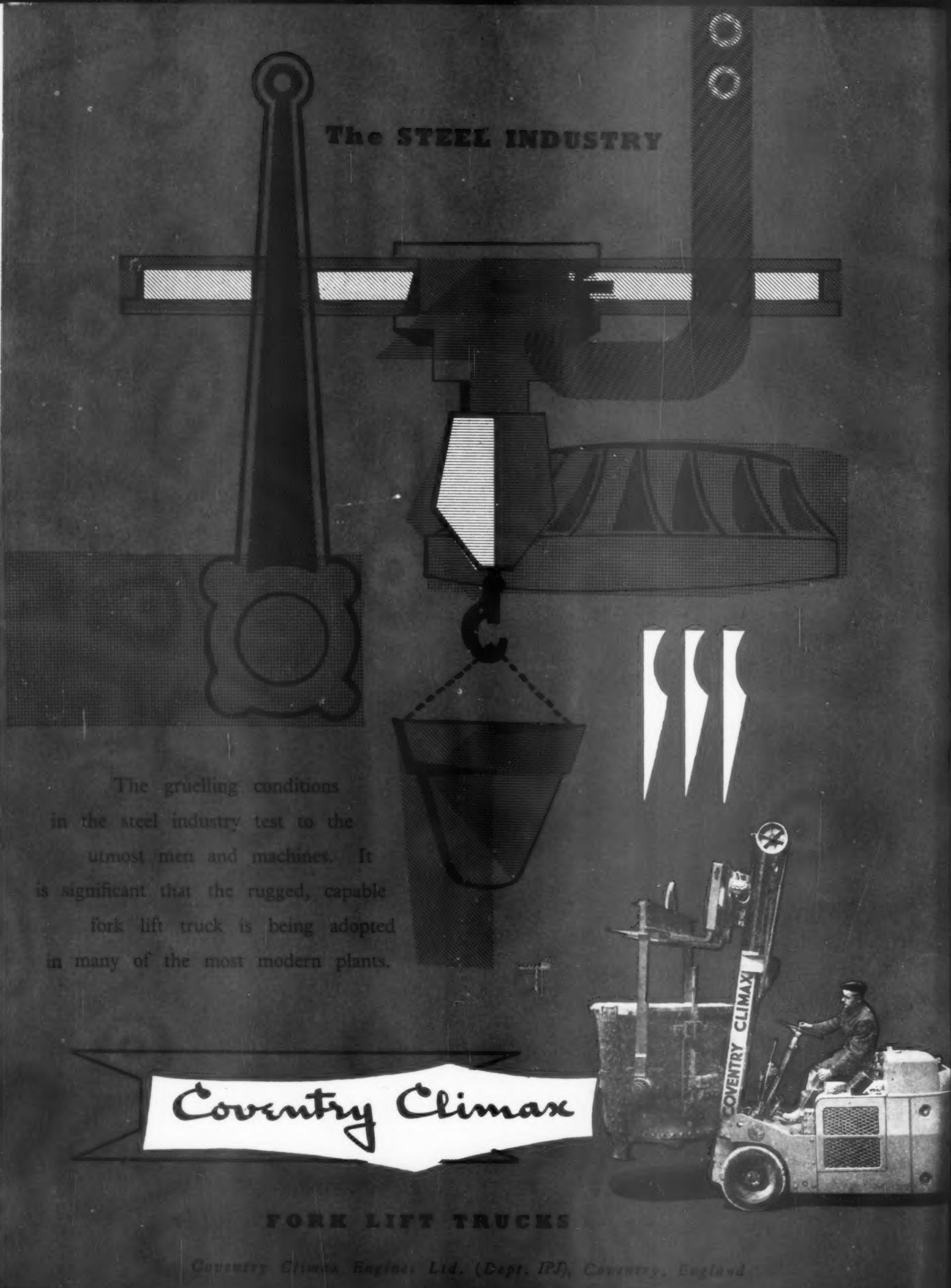
the best hack saw blade

"Eclipse" hack saw blades, tool bits and other engineers tools are made by: James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors

UH2

INDEX TO ADVERTISEMENTS

All communications regarding advertisements should be addressed to the Advertising Managers, T. G. Scott & Son, Ltd. Crown House, 143-147, Regent Street, London, W.1. Phone: Regent 3891.
Printed by Maxwell, Love & Co. Ltd., White Lion Street, London, N.1.



The STEEL INDUSTRY
The gruelling conditions in the steel industry test to the utmost men and machines. It is significant that the rugged, capable fork lift truck is being adopted in many of the most modern plants.
COVENTRY CLIMAX
Coventry Climax
FORK LIFT TRUCKS
Coventry Climax Engines Ltd. (Dept. IPJ), Coventry, England